STYRENE PARK OFFSITE

Document Title:

Test Procedure For Air Condenser and Chiller

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REVISION RECORD SHEET

Page	Revisions								Page	Revisions						
	R0	R1	R2	R3	R4	R5	R6			R0	R1	R2	R3	R4	R5	R6
1	X	X							41	X	X					
2	X	X							42	X	X					
3	X	X							43	X	X					
4	X	X							44	X	X					
5	X	X							45	X	X					
6	X	X							46	X	X					
7	X	X							47	X	X					
8	X	X							48	X	X					
9	X	X							49	X	X					
10	X	X							50	X	X					
11	X	X							51	X	X					
12	X	X							52	X	X					
13	X	X							53	X	X					
14	X	X							54	X	X					
15	X	X							55	X	X					
16	X	X							56	X	X					
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18	X	X							58	X	X					
19	X	X							59	X	X					
20	X	X							60	X	X					
21	X	X							61	X	X					
22	X	X							62	X	X					
23	X	X							63	X	X					
24	X	X							64	X	X					
25	X	X							65	X	X					
26	X	X							66	X	X					
27	X	X							67	X	X					
28	X	X							68	X	X					
29	X	X							69	X	X					
30	X	X							70	X	X					
31	X	X							71	X	X					
32	X	X							72	X	X					
33	X	X							73	X	X					
34	X	X							74	X	X					
35	X	X							75	X	X					
36	X	X							76	X	X					
37	X	X							77	X	X					
38	X	X							78	X	X					
39	X	X							79	X	X					
40	X	X							80-115	X	X					

NDT Procedure & Weld/NDT Map for Air cooler

44.0 Examination

45.0 Evaluation

46.0 ACCEPTANCE CRITERIA

47.0 EXAMNATION REPORT (APPENDIX 1)

1.0. PURPOSE

This procedure defines the methods of performance, the examination conditions and the precautions to be taken when liquid penetrant examination is carried out of Air-cooled heat exchangers of "
Toase ehe Park Sanati Gohar Ofogh Petrochemical Co.
CONCEPTUAL, BASIC and DETAIL DESIGN ENGINEERING OF STYRENE PARK OFFSITE "

2.0. SCOPE

This procedure is applicable for carry out testing on welded joints of header boxes of air-cooled heat exchanger and Materials, shapes, or sizes to be examined and the extent of examination are according to NDT. CHECK LIST & NDT MAP of project.

In principle, a liquid penetrant is applied to the surface to be examined and allowed to enter discontinuities. All excess penetrant is then removed, the part is dried, and a developer is applied. The developer function both as a blotter to absorb penetrant that has been trapped in discontinuities, and as a contrasting background to enhance the visibility of penetrant indications. The dyes in penetrants are either color contrast (visible under white light) or fluorescent (visible under ultraviolet light).

3.0. REFERENCES

3.1. ASME Sec.V- edition 2010

3.2. NDT. CHECK LIST & NDT MAP: EI027-DMF-VD-QC-PRO-023

3.3. ASME section VIII div.1 edition 2010 addendum 2011 shall be added

3.4 ASME B31.3

3.5 ASTM E165

4.0. DEFINITION

4.1. Relevant Indications:

Indications with major dimensions greater than 1/16 (1.5 mm)

4.2. Linear Indications:

An indication having a length greater than three times the width.

4.3. Rounded Indications

An indication of circular or elliptical shape with the length equal or less than three times the width.

5.0. SURFACE PREPARATION

5.1. In general, satisfactory results may be obtained when the surface of the part is in the as welded, as-rolled, as-cast, or as-forged condition. Surface preparation by grinding, machining,

Or other methods may be necessary where surface irregularities could mask indications.

5.2. Prior to each liquid penetrant examination, the surface to be examined and all adjacent areas within at least 1 in(25mm) shall be dry and free of all dirt, grease, lint, scale, welding flux, weld spatter, paint, oil, and other extraneous matter with using Hand tool cleaner like Brush.

Oil, paint, grease shall be cleaned with a solvent.

6.0. DRYING AFTER PREPARATION

After cleaning, drying of the surfaces to be examined shall be accomplished by normal evaporation or with forced hot or cold air. A minimum period of time

shall be established to ensure that the cleaning solution has evaporated prior to application of the penetrant.

The surface of the part to be processed shall not be below 40°F (5°C) nor above 125°F(52°C). The air pressure shall not exceed 30psi (206KPa).

7.0. TECHNIQUES

7.1. Technique for Standard Temperature

As a standard technique, temperature of the penetrant and the surface of the part to be processed shall not be below 50ºF (10ºC) nor above 125ºF (52ºC) throughout the examination period. Local heating or cooling is permitted provided the part temperature remains in the range of 50ºF to 125ºF (10ºC to 52ºC) during the examination.

7.2. Techniques for Nonstandard Temperatures

When it is not practical to conduct a liquid penetrant examination within the temperature range of 40°F to 125°F (5°C to 52°C), the examination procedure at the proposed lower or higher temperature range requires qualification of the penetrant materials and processing in accordance with Mandatory Appendix III of this Article.

7.2. Technique Restriction

Fluorescent penetrant examination shall not follow a color contrast penetrant examination. Intermixing of penetrant materials from different families or different manufacturers is not permitted. A retest with water washable penetrants may cause loss of marginal indications due to contamination.

Either a color contrast (visible) penetrant or a fluorescent shall be used with water washable technique.

8.0. CALIBRATION

Light meters, both visible and fluorescence (black) light meters shall be calibrated at least once a year or whenever the meter has been repaired. If meters have not been in use for one year or more, calibration shall be done before being used.

9.0. EXAMINATION

9.1. Penetrant Application

The penetrant should be applied by spraying.

9.2. Penetration (Dwell) Time

Penetration (dwell) time is critical. The minimum penetration time shall be as required in following table (1) or as qualified by demonstration for specific applications.

9.3. Excess Penetrant Removal

After the specified penetration (dwell) time has elapsed, any penetrant remaining on the surface shall be removed, taking care to minimize removal of penetrant from discontinuities.

Excess penetrant shall be removed with a water spray. The water pressure shall not exceed 50 psi (350KPa) (According to ASME Sec V T-673.1), and the water temperature shall not exceed 110ºF(43ºc).

9.4. Fluorescent Penetrants.

With fluorescent penetrants, the process is essentially the same as in T-676.3, with the exception that the examination is performed using an ultraviolet light, called black light. The examination shall be performed as follows:

(a) It shall be performed in a darkened area.

(b) Examiners shall be in a darkened area for at least 5 min prior to performing examinations to enable their eyes to adapt to dark viewing. Glasses or lenses worn by examiners shall not be photosensitive.

(c) Black lights shall achieve a minimum of 1000W/cm2 on the surface of the part being examined throughout the examination.

(d) Reflectors and filters should be checked and, if necessary, cleaned prior to use. Cracked or broken filters shall be replaced immediately.

(e) The black light intensity shall be measured with a black light meter prior to use, whenever the light's power source is interrupted or changed, and at the completion of the examination or series of examinations.

9.5. Drying After Excess Penetrant Removal

For the water washable technique, the surface may be dried by blotting with clean materials or by using circulating air, provided the temperature of the surface is not raised above 125ºF(52ºC).

Material	*Form*	*Type of Discontinuity*	*Minimum Dwell Times (minutes)* * Note1	
			Penetrant	Developer
Steel	Welds	Cold shuts, Porosity, Lack of fusion, Cracks (all forms)	5	10

Table (1) Ref.: TABLE T-672- ASME SEC.V ARTIVLE 6

*Note1: For temperature range from 50ºF to 125ºF (10ºC to 52ºC)

9.6.1. For temperatures from 5ºC to 10ºC, minimum penetrant dwell time shall be 2 times the value listed.

9.7 Developing

9.7.1. The developer shall be applied as soon as possible after penetrant removal; the time interval shall not exceed that established in the procedure. Insufficient coating thickness may not draw the penetrant out of discontinuities conversely, excessive thickness may mask indications.

With color contrast penetrants, only a wet developer shall be used. With fluorescent penetrants, a wet or dry developer may be used.

9.7.2. Developing time for final interpretation begins immediately after the application of a dry developer or as soon as a wet developer coating is dry. The minimum developing time shall be as required by Table.1 and minimum 10 minutes.

9.7.3. Developer Application

The developer should be applied by spraying.

9.8. Minimum time periods between steps and drying aids is 10 minutes.

Maximum time periods between steps and drying aids is 30 minutes.

10.0. INTERPRETATION

Final interpretation shall be made within 10 to 60 min. after the requirement of procedure are satisfied. Using a 1000 lux light All relevant indications shall be recorded and evaluated as per ASME sec. VIII Div. 1.

11.0. ACCEPTANCE CRITERIA

Liquid penetrant techniques shall be judged unacceptable when the examination exhibits any indication in excess of the limits specified below :(According to ASME Sec. VIII Div.1 Appendix8):

(I)-Any type of crack

(II)- Relevant linear indication

(III)-Relevant rounded indications greater than 3/16 in. (5mm)

(IV)-Four or more relevant rounded indications in a line separated by 1/16 in (1.5 mm) or less (edge to edge).

12.0. POST-EXAMINATION CLEANING

When post-examination cleaning is required by the procedure, it should be conducted as soon as practical after evaluation.

After evaluation the remaining material to be removed by Proper solvent or water and clean cloth.

13.0. DOCUMENTATION

13.1. Recording of Indication

(a) Non reject able Indication

Non rejectable indications shall be recorded as specified by the referencing Code Section.

(b) Reject able Indications

Reject able indications shall be recorded. As a minimum, the type of indications (linear or rounded), location and extent (length or diameter or aligned) shall be recorded.

13.2. Examination Report

For each examination, the following information shall be recorded (As a minimum, the examination report shall include required information, described in article 6. ASME section V)

Procedure identification and revision

Liquid penetrant type (visible or fluorescence)

Type (number or letter designation) of each penetrant, penetrant remover, and developer used.

Examination personnel identify and, qualification level

Map or record of indications Per T-691 ASME SEC.V

Material and thickness

Lighting equipment

Date and time examination were performed.

The report shall be signed and dated by the qualified and certified level II/III.

Examination report shall be prepared and furnished to the client.

14. CERTIFICATION

After examination a liquid penetrant examination report shall be filled out, in accordance with requirements of part T.693 of ASME Code sec. V

15. PERSONNEL QUALIFICATION

Operators shall be qualified and certified in accordance with SNT-TC-1A.

All NDE shall be done by personnel certified to SNT-TC-1A level II /III.

15.1. Performance Demonstration

When be required is according to ASME SEC.V Article 14. T-1423

16. Repair and re-examination of defective weld

Any weld defects shall be fully chipped out, and the repair cavity shall be inspected by the liquid penetrant method. The repair welding shall be re-examined after the required heat treatment.

17.0. PURPOSE

This procedure describes the procedure for radiographic examination of welds of Air-cooled heat exchangers that will be procured in "**Toase-ehe Park Sanati Gohar Ofogh Petrochemical Co. CONCEPTUAL, BASIC and DETAIL DESIGN ENGINEERING OF STYRENE PARK OFFSITE**"

18.0. SCOPE

This procedure is applicable for carry out testing on flange to pipe or obround butt welds of header boxes of air cooled heat exchanger and materials, shapes, or sizes to be examined and the extent of examination are according to NDT. CHECK LIST & NDT MAP of project .

19.0. REFERENCES

19.1. API-661-Edition 2006

19.2.ASME sec V-Edition 2010

19.3.ASNT-TC-1A-Edition 2006

19.4. ASME Section VIII Div.1 edition 2010 addendum 2011 shall be added.

20.0. DEFINITION

20.1. I.Q.I: Image Quality Indicator

21.0. GENERAL REQUIREMENTS

21.1. Particular instruction

The particular instruction shall refer to the general examination specification

- The areas of the part to be examined,
- Materials and thickness ranges to be radiographed,
- Isotope used
- Film brand or type to be used,
- Screens to be used,
- Acceptance criteria.

21.2. Operator qualification

Operators shall be qualified and certified in accordance with SNT-TC-1A-Edition 2006 last applicable edition.

All NDE shall be done by or under the supervision of personnel certified to SNT- TC-1A-Edition 2006 level II/III.

22.0. SURFACE PREPARATION

22.1. Materials

Surfaces shall satisfy the requirements of the applicable material specifications, with additional conditions if necessary. In that case, surface irregularities shall be removed by any appropriate means so as not to mask indications or interfere with them.

22.2. Welds

The welds ripples or weld surface irregularities on both the inside (where accessible) and

outside shall be removed by any suitable process to such a degree that the resulting radiographic image due to any irregularities cannot mask or be confused with the image of any discontinuity.

The finished surface of all butt-welded joints must be smoothly blended into the base material

within the limits specified in the referencing code section (ASME SEC.VIII-Edition 2012-U-35).

Permitted reinforcement on each face as following:

	Maximum Reinforcement, mm.
Material Nominal Thickness, mm	Butt Welds
Less than 2.4	2.4
2.4 to 4.8, incl.	3.2
Over 4.8 to 13, incl.	4.0
Over 13 to 25, incl.	4.8
Over 25 to 51, incl.	5
Over 51 to 76, incl.	6
Over 76 to 102, incl.	6
Over 102 to 127, incl.	6
Over 127	8

23.0. EQUIPMENT USED

23.1. Film selection

Radiographs shall be made using industrial radiographic film ASTM type (***Very fine grain film must be use (KODAK MX125) with 10Cm width***).

23.2. Intensifying screens

Intensifying lead screens may be used except when otherwise specified. Good screen-film contact is essential to get a good result. Thickness of front & back screen: 0.1 mm

23.3. Back scatter protection

A back lead layer has to be used in order to:

-reduce the scattering of the radiations,

-avoid secondary back-scattered radiations

This back lead layer shall be placed on the back of each film holder / cassette.

A lead symbol "B" with dimensions of 13 mm (1/2 inch) in height, and 1, 6 mm (1/16 inch) in thickness has to be attached on the back of the film holder.

If a light image of the "B" appears on a darker background of the radiograph, protection from backscatter is insufficient and the radiograph shall be considered unacceptable.

A dark image of the "B" on a lighter background is not cause for rejection.

Intensifying and back lead screens shall be perfectly clean, free from scratches, crimps, blemishes or folds.

23.4. Irradiation equipment

23.4.1. Radioactive sources

Generally, the minimum thickness for which radioactive sources may be used is as less thickness may be radiographed with these sources if it is demonstrated that the required sensitivity can be obtained.

The maximum thickness for the use of radioactive sources is primarily dictated by exposure time. Therefore upper limits are not shown.

Material	Minimum Thickness	
	Iridium 192	Cobalt 60
Steel	19 mm	38 mm
High Nickel Alloy	17 mm	33 mm

23.4.2. Special conditions

When an examination is performed, which strays from the conditions fixed above, or when other sources are used, a procedure for the particular examination must be issued.

In any case, the radiographic sensitivity depends essentially on:

-Film selection,

-Intensifying screen selection,

-Geometrical un sharpness,

-Film density.

23.5. Image quality indicators (Penetrometers)

23.5.1. Sensitivity of the radiographic technique (T 283)

The sensitivity of the radiographic technique shall be sufficient to display the penetrometer image and the specified wire of the penetrometer which are essential indications of the image quality of the radiograph. It shall also allow displaying the numbers and letters used to identify the films.

All radiographs shall show appropriate image quality indicators (penetrometers), in compliance with ASME codes. However the sensitivity shall not be lower than 2% of the thickness.

23.5.2. Selection of the penetrometers

23.5.2.1. Material

The penetrometers shall be made in a material with similar absorption coefficient to that of the material to be radiographed.

23.5.2.2. General dimensions of the penetrometers

The penetrometers shall be of the hole or wire type and its dimensions and geometry are given by the figures in 7.5.2.3.

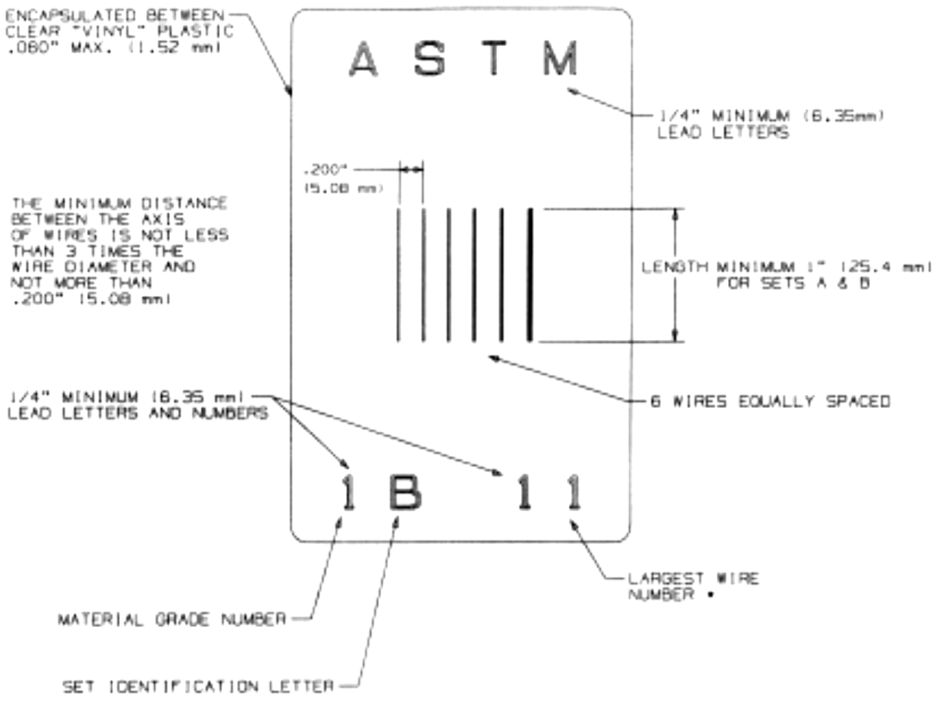
Variations of length and /or width are accepted.

Other penetrometers may be used but require a special qualification and an agreement by contract.

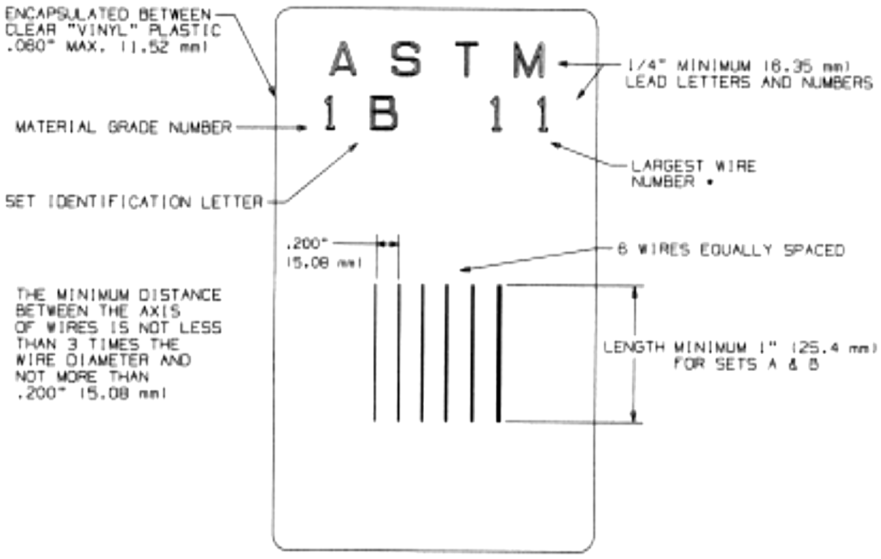
23.5.2.3. Identification of the penetrometers(s)

The penetrometer shall be identified by lead numbers located in an appropriate area.

PENETRAMETERS WITH WIRE



Design for wire type IQI (SETA&B)-Alternate 1(Fig. 3 SE 747 Art. 22 ASME Sec. V)



Design for wire type IQI (SETA&B)-Alternate 2(Fig. 4 SE 747 Art. 22 ASME Sec. V)

7.5.2.4. PENETRAMETER DESIGNATION AND WIRE DIAMETERS

The following table shows the diameter of the wires of the different types of penetrometers.

SET A		SET B	
Wire Diameter, in. (mm)	Wire Identity	Wire Diameter, in. (mm)	Wire Identity
0.0032 (0.08)[A]	1	0.010 (0.25)	6
0.004 (0.1)	2	0.013 (0.33)	7
0.005 (0.13)	3	0.016 (0.4)	8
0.0063 (0.16)	4	0.020 (0.51)	9
0.008 (0.2)	5	0.025 (0.64)	10
0.010 (0.25)	6	0.032 (0.81)	11
SET C		**SET D**	
Wire Diameter, in. (mm)	Wire Identity	Wire Diameter, in. (mm)	Wire Identity
0.032 (0.81)	11	0.10 (2.5)	16
0.040 (1.02)	12	0.126 (3.2)	17
0.050 (1.27)	13	0.160 (4.06)	18
0.063 (1.6)	14	0.20 (5.1)	19
0.080 (2.03)	15	0.25 (6.4)	20
0.100 (2.5)	16	0.32 (8)	21

TABLE 3
WIRE DIAMETER TOLERANCES (in.)

Wire Diameter (d), in	Tolerance, in
$0.000 < d \leq 0.005$	±0.0001
$0.005 < d \leq 0.010$	±0.0002
$0.010 < d \leq 0.020$	±0.0004
$0.020 < d \leq 0.063$	±0.0008
$0.063 < d \leq 0.160$	±0.0012
$0.160 < d \leq 0.320$	±0.0020

23.5.2.5. Selection of the penetrometer versus the thickness to be radio graphed

The tables on the next page give the selection elements of the penetrometer and the diameter of the characteristic hole or wire versus the thickness to be radio graphed.

23.5.2.5.1. Welds with reinforcements:

The thickness on which the penetrometer is based is the nominal single wall thickness plus the estimated weld reinforcement not to exceed the maximum permitted (according to section 7.2). Backing rings or strips shall not be considered as part of the thickness in penetrometer selection. The actual measurement of the weld reinforcement is not required.

23.5.2.5.2. Welds without reinforcements:

The thickness on which the penetrometer is based is the nominal single wall thickness. Backing rings or strips shall not be considered as part of the weld thickness in penetrometer selection.

23.5.2.6. Placement of penetrometers (T 277.1)

The penetrometer(s) shall be placed on the weld so that the length of the wires is perpendicular to the length of the weld. The identification numbers and lead letter "F", when used, shall not be in the area of interest, except for the conditions described in the above mentioned two cases.

For the material other than welds, the penetrometer and its identification, as well as the letter "F" when used, shall be placed in the area of interest.

If for reasons if inaccessibility, it is impossible to place the penetrometer on the source side, it shall be placed on the film side on the part and a lead letter "F", at least as high as the identification number to the penetrometer, shall be placed adjacent to or on the penetrometer.

Nominal Single-Wall Material Thickness Range, in. (mm)	IQI					
	Source Side			Film Side		
	Hole-Type Designation	Essential Hole	Wire-Type Essential Wire	Hole-Type Designation	Essential Hole	Wire-Type Essential Wire
Up to 0.25, incl. (6.4)	12	2T	5	10	2T	4
Over 0.25 through 0.375(6.4 through 9.5)	15	2T	6	12	2T	5
Over 0.375 through 0.50 (9.5 through 12.7)	17	2T	7	15	2T	6
Over 0.50 through 0.75 (12.7 through 19.0)	20	2T	8	17	2T	7
Over 0.75 through 1.00 (19.0 through 25.4)	25	2T	9	20	2T	8
Over 1.00 through 1.50 (25.4 through 38.1)	30	2T	10	25	2T	9
Over 1.50 through 2.00 (38.1 through 50.8)	35	2T	11	30	2T	10
Over 2.00 through 2.50 (50.8 through 63.5)	40	2T	12	35	2T	11
Over 2.50 through 4.00 (63.5 through 101.6)	50	2T	13	40	2T	12
Over 4.00 through 6.00 (101.6 through 152.4)	60	2T	14	50	2T	13
Over 6.00 through 8.00 (152.4 through 203.2)	80	2T	16	60	2T	14
Over 8.00 through 10.00 (203.2 through 254.0)	100	2T	17	80	2T	16
Over 10.00 through 12.00 (254.0 through 304.8)	120	2T	18	100	2T	17
Over 12.00 through 16.00 (304.8 through 406.4)	160	2T	20	120	2T	18
Over 16.00 through 20.00 (406.4 through 508.0)	200	2T	21	160	2T	20

Selection of the penetrometer

When the shape of the part or its dimensions do not allow to place the penetrometer(s) on the part, the penetrometer(s) may be placed on a separate block provided that the block:

-Is made of a material, radio graphically similar to the part,

-Has the same thickness as the part being radiographed,

-Is located as close as possible to the material being radiographed

The block dimensions shall exceed the penetrometer dimensions such that the outline of at least three sides of the penetrometer image shall be visible on the radiograph.

23.5.2.7. Number of penetrometers

a) For components where one or more film holders are used for an exposure, at least one penetrometer image shall appear on each radiograph. If the density of the radiograph anywhere through the area of interest varies by more than minus 15% or plus 30% from the density through the body of the penetrometer, within the minimum/maximum allowable density ranges specified

in subparagraph 9.2, then an additional penetrometer shall be used for each exceptional area or areas and the radiograph retaken. When calculating the allowable variation in density, the calculation may be rounded to the nearest 0.1.

b) If the requirements of 7.5.2.7.a) and 8.2. are met by using more than one penetrometers, one shall be representative of the lightest area of interest and the other the darkest area of interest ; in that case, the intervening densities on the radiograph shall be considered as acceptable.

24.0. RADIOGRAPHIC DENSITY

24.1. Equipment used (T 262)

The density of the radiographic film shall be verified by means of

-Either a densitometer,

-Or a step wedge comparison film

The densitometer (or the step wedge comparison film) shall be verified by means of a calibrated step wedge film traceable to a national standard. The densitometer will be calibrated according to PI 022.

24.2. Limitation of the radiographic density (T 282.1)

The transmitted film density through the radiographic image of the body of the appropriate penetrometer and the area of interest shall be:

-For single film technique = 2.0. Minimum for radiographs made with Gamma-ray sources,

-For composite viewing of multiple film exposures, each film of the composite set shall have a minimum density of 1.3.

The maximum density shall be 4 for either single or composite viewing.

A tolerance of 0.05 in density is allowed for variations between densitometer readings.

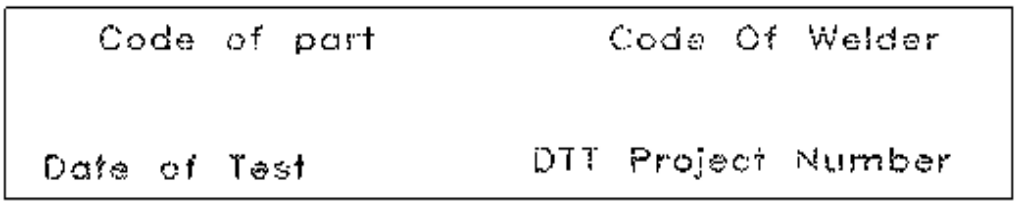
25.0. IDENTIFICATION OF RADIOGRAPHS

25.1. System of film identification (T 224)

A system shall be used to produce permanent identification on the radiograph traceable to the order number, the part, the weld or the weld seam or part numbers as appropriate.

In addition, the date of the radiograph shall be plainly and permanently included on the radiograph. This identification system does not necessarily required that the information appear as radiographic images.

In any case, this information shall not obscure the area of interest.



Film location markers (T 275) .a

Location markers, which are to appear as radiographic images on the film, shall be placed on the part to be radiographed and not on the film holder / cassette.

Their locations shall be marked on the surface of the part being radiographed or on a map, in a manner permitting the area of interest on a radiograph to be accurately traceable to its location on the part for the required retention period of the radiograph, and provide evidence on the radiograph that the required coverage of the region being examined has been obtained.

26.0. GEOMETRICAL UNSHARPNESS (T 274)

26.1. Definition of geometrical unsharpness

The geometrical unsharpness is given by the equation:

with :

$$U_g = \frac{F \cdot d}{D}$$

- Ug (mm) is the geometrical unsharpness,

-F (mm) is the maximum projected dimension of the radiating source or focal spot in the plane perpendicular to the distance D from the weld or the part being radiographed, ٤٨,٠

-D (mm) is the distance from source of radiation to weld or other object being radiographed, ٤٩,٠

-d (mm) is the distance from source side of weld or object being radiographed to the film.

26.2. Limitations of the geometrical unsharuness (T 285)

In the case of Section VIII the limitations below are only to be taken as a guide, the quality of the radiograph being judged according to the possibility of discerning the characteristic wire of penetrometer.

Material thickness (mm)	Ug maximum (mm)
Under 50	0.510
50 through 75	0.760
Over 75 through 100	1.020
Greater than 100	1.780

Note: Material thickness is the thickness on which the penetrometer is based.

27.0. FILM PROCESSING

The conditions of manual processing procedure are as follows:

a) Developer: temperature 20°C (68ºF), time = 5 or 8 min (according to the type of film);

b) Rinsing: stop bath = aqueous solution with 2% acetic acid, temperature 20°C (68ºF), time = 1 min;

c) Fixing: temperature 20°C (68ºF), time = 8 min

d) Washing: filtered water, room temperature, time = 10 min

e) Glazing: wetting agent, room temperature, time = 2 or 3 min immersions

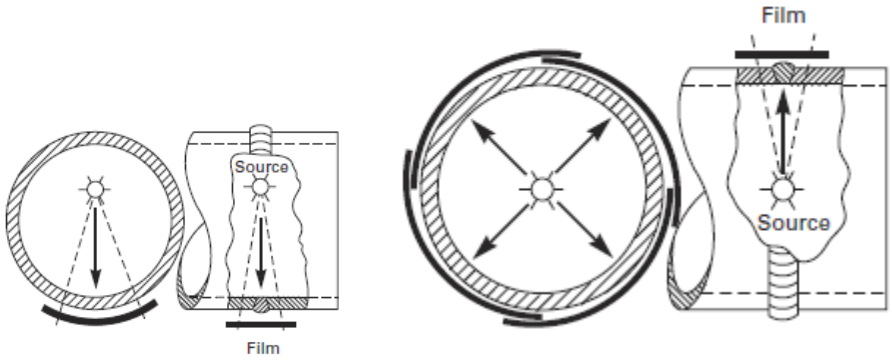
f) Drying: Ambient temperature

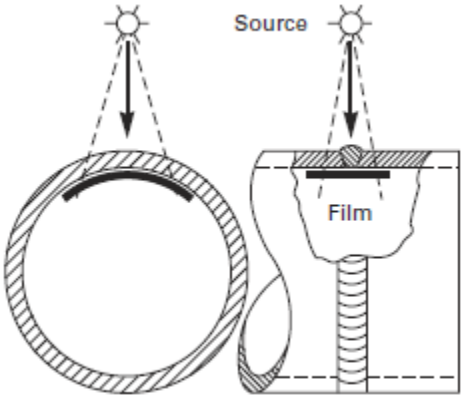
28.0. RADIOGRAPHIC TECHNIQUE

A single-wall exposure technique shall be used for radiography whenever practical. When it is not practical to use a single-wall technique, a double-wall technique shall be used.

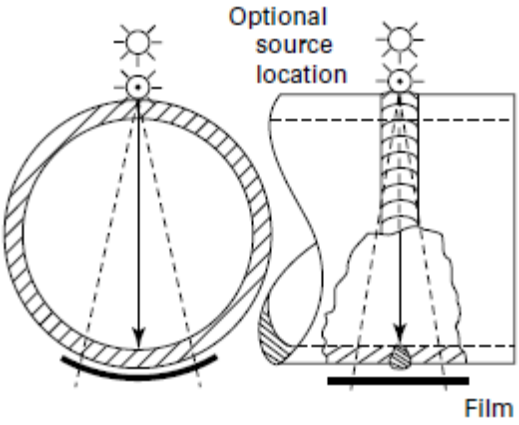
28.1. Single-wall technique

In the single-wall technique, the radiation passes through only one wall of the weld (material), which is viewed for acceptance on the radiograph. An adequate number of exposures shall be made to demonstrate that the required coverage.

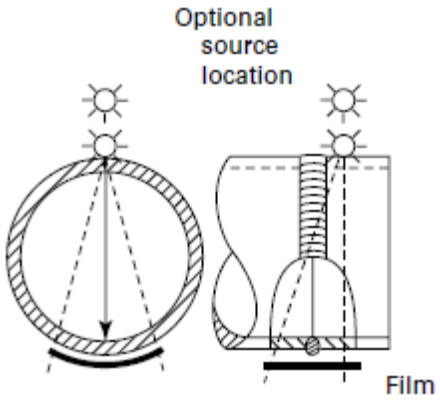




Exposure Arrangement — C



Exposure arrangement — D



Exposure arrangement — E

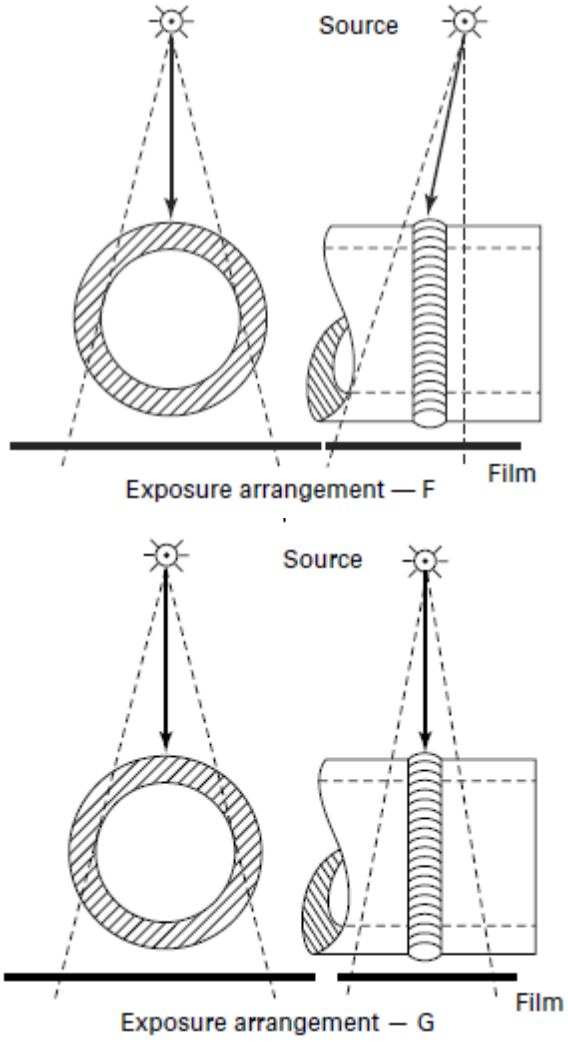
SINGLE-WALL RADIOGRAPHIC TECHNIQUES (According to Fig.A-210-1 ASME SEC.V-Ed.2010)

28.2. Double -wall technique

12.2.1. For circumferential welds 4 in. (100 mm) outside diameter (3.5 in. nominal pipe size) or less, use a technique in which the radiation passes through both walls and both walls are viewed for acceptance on the same image. Unless otherwise specified, either elliptical or superimposed projections may be used. A sufficient number of views should be taken to examine the entire weld. Where design or access restricts a practical technique from examining the entire weld, agreement between contracting parties must specify necessary weld coverage.

12.2.2. For circumferential welds greater than 4 in.(100 mm) outside diameter (3.5 in. nominal pipe size), use a technique in which only single-wall viewing is performed.

A sufficient number of views should be taken to examine the entire weld. Where design or access restricts a practical technique from examining the entire weld, agreement between contracting parties must specify necessary weld coverage.



DOUBLE-WALL RADIOGRAPHIC TECHNIQUES (According to Fig.A-210-1 ASME SEC.V-Ed.2010)

29.0. INTERPRETATION OF RADIOGRAPHS

29.1. Prior to being presented to the Inspector for acceptance, the radiographs shall be examined and interpreted by the Manufacturer as complying with the referencing Code Section. The Manufacturer shall record the interpretation of each radiograph and disposition of the material examined on a radiographic interpretation review form accompanying the radiographs

29.2. Viewing facilities shall provide background lighting of an intensity that will not cause troublesome reflections, shadows, or glare on the radiograph. Equipment used

to view radiographs for interpretation shall provide a variable light source sufficient for the essential penetrometer hole or designate wire to be visible for the specified density range. The viewing conditions shall be such that light from around the outer edge of the radiograph or coming through low-density portions of the radiograph does not interfere with interpretation.

29.3. The nightscope used shall allow the interpretation of films with 4.0 density.

29.4. The films shall be free from any processing defects, scratches or any other blemishes that could interfere with the interpretation.

13.5. Films shall be interpreted dry.

30.0. EVALUATION OF INDICATIONS

The evaluation of indications shall be made in terms of the acceptance criteria given in the applicable ASME Code Section and the particular specifications.

30.1. Questionable indications

Any questionable indication shall be considered as a defect, unless a re-examination using the same examination method or any other suitable non-destructive examination method can demonstrate that such a questionable indication is not a defect.

31.0. ACCEPTANCE CRITERIA

31.1. Terminology

a) Linear Indication:

Cracks, incomplete fusion, inadequate penetration, and slag are represented on the radiograph as linear indication in which the length is more than three times the width.

B) Rounded Indication:

Porosity and inclusions such as slag or tungsten are represented on the radiograph as rounded indication with a length three times the width or less.

These indications may be circular, elliptical, or irregular in shape; may have tails; and may vary in density.

C) Aligned Indications:

A sequence of four or more rounded indications shall be considered to be aligned when they touch a line parallel to the length of the weld drawn through the centre of the two outer rounded indications.

D) Thickness

The thickness of the weld excluding any allowable reinforcement. For a butt weld joining two members having different thicknesses at the weld, t is the thinner of these two thicknesses.

31.2. Acceptance Criteria:

The following discontinuities are considered unacceptable (According to ASME Sec.VIII- Div.1-UW-51-Ed.2010).

(I)Linear Indications:

I.1) any type of crack or zone of incomplete fusion or penetration.

I.2) any elongated slag inclusion which has a length greater than:

a. 6 mm for t up to 19mm

b. ⅓ t for t over 19mm to 57mm

c. 19 mm for t over 57mm

I.3) any group of aligned inclusions that have an aggregate length greater than t in a length 12 t , except when the distance between the successive imperfections exceeds 6L where L is the length of the longest imperfection in the group.

(II) Rounded Indications (According to ASME SEC.VIII Div.1-APP.4-ED.2010)

II.a) Relevant indications

Only those rounded indications which exceed the following dimensions shall be considered relevant.

II.a.1) 1/10 t for t less than 3mm

II.a.2) 0.4mm for t from 3mm to 6 mm, incl.

II.a.3) 0.8mm for t greater than 3mm to 50mm, incl.

II.a.4) 1.6mm for t greater than 50mm

II.b) Maximum size of rounded indication

The maximum permissible size of any indication shall be 1/4 t, or 4mm, whichever is smaller; except that an isolated indication separated from an adjacent indication by 25mm or more may be 1/3 t or 6mm, whichever is less. For t greater than 50mm the maximum permissible size of an isolated indication shall be increased to 10mm.

II.c) Aligned rounded indications

Aligned rounded indications are acceptable when the summation of the diameters of the indications is less than t in e length of 12t. (See fig 15.1.1). The length of groups of aligned rounded indications

and the spacing between the groups shall meet the requirements of Fig.51.2

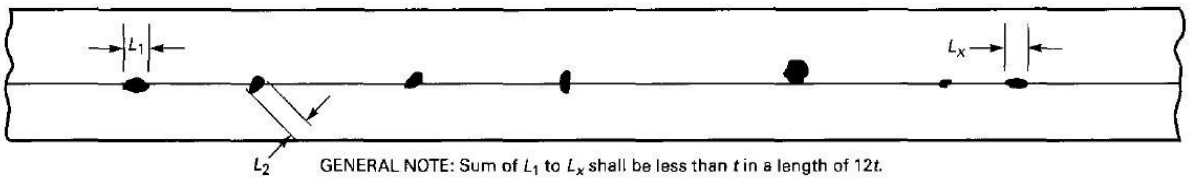
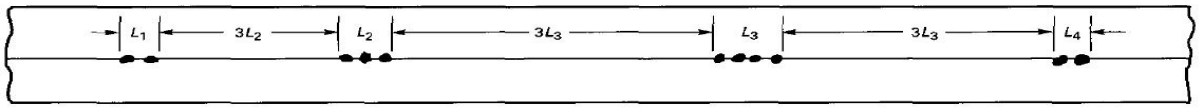


Fig.15.1.1. Aligned rounded indications



GENERAL NOTE: Sum of the group lengths shall be less than t in a length of $12t$.

Maximum Group Length	Minimum Group Spacing
L = 1/4 in. (6 mm) for t less than 3/4 in. (19 mm) L = 1/3t for t 3/4 in. (19 mm) to 2 1/4 in. (57 mm) L = 3/4 in. (19 mm) for t greater than 2 1/4 in. (57 mm)	3L where L is the length of the longest adjacent group being evaluated.

Fig.15.1.2. Groups of aligned rounded indications

II.d) Spacing

The distance between adjacent rounded indications is not a factor in determining acceptance or rejection, except as required for isolated indications or groups of aligned indications.

II.e) Rounded Indication Charts:

The rounded indications characterized as imperfections shall not exceed that shown in the charts.

The charts in Figs.15.1.3 through 15.1.8 illustrate various types of assorted, randomly dispersed and clustered rounded indications for different weld thicknesses greater than 1/8 in (3mm). These charts represent the maximum acceptable concentration

limits for rounded indications. The charts for each thickness range represent full-scale 6 in.(150mm) radiographs, and shall not be enlarged or reduced. The distributions shown are not necessarily the patterns that may appear on the radiograph, but are typical of the concentration and size of indications permitted.

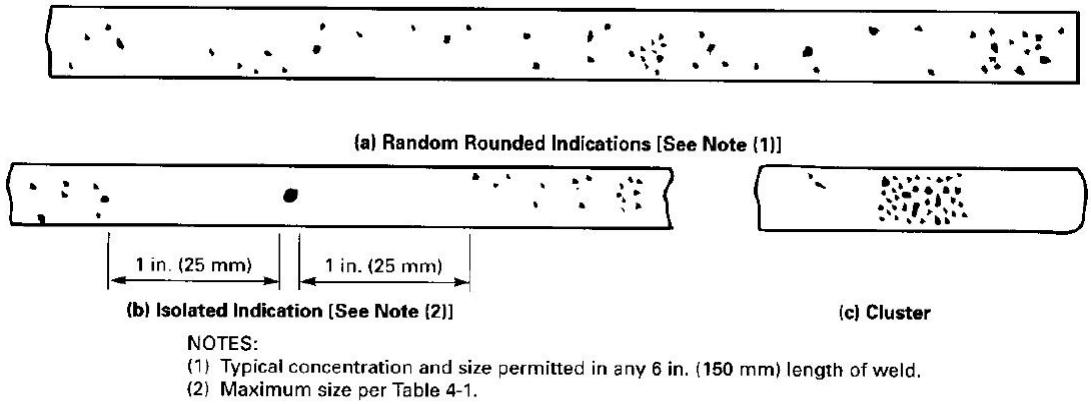


Fig.15.1.3. *Charts for t equal to 1/8 in. to 1/4 in (3 to 6 mm) inclusive*

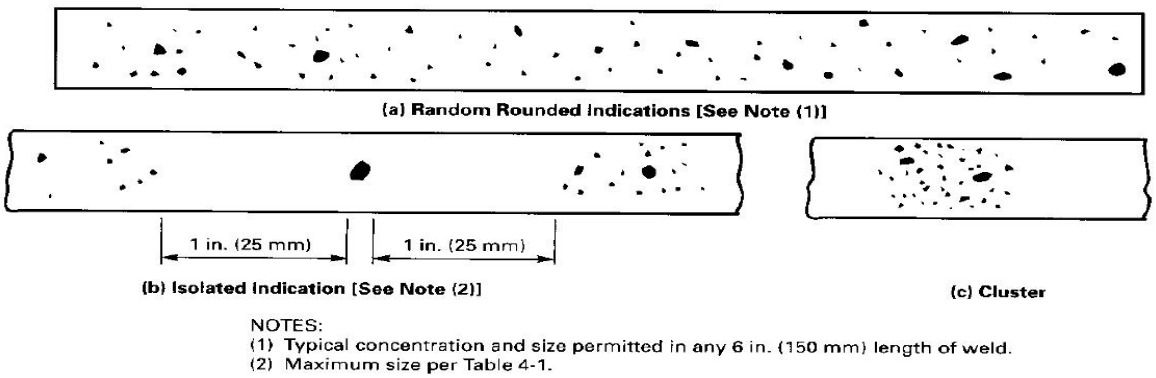


Fig. 15. 1. 4 . *Charts for t equal to over 1/4 in. to 3/8 in. (6 to 10 mm) inclusive*

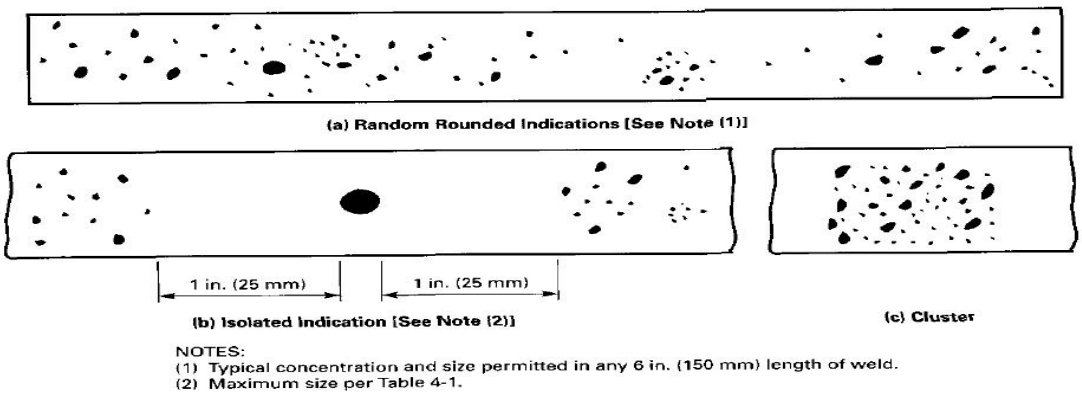


Fig. 15. 1. 5 *Charts for t equal to over 3/8 in. to 3/4 in. (10 to 19 mm) inclusive*

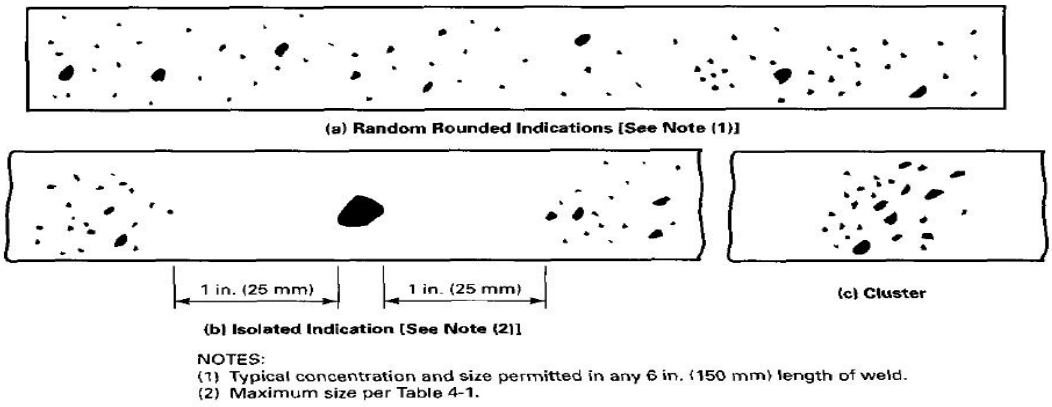


Fig. 15. 1. 6. *Charts for t equal to over 3/4 in. to 2 in. (19 to 50 mm) inclusive*

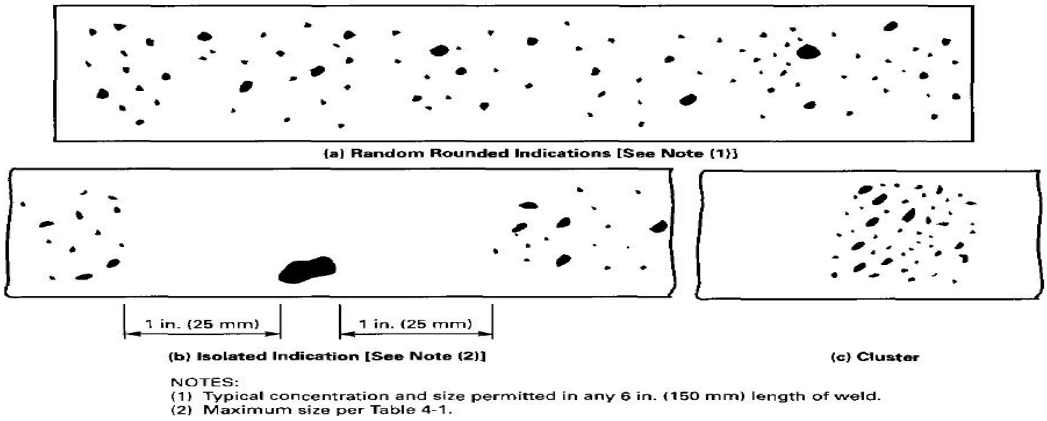


Fig. 15. 1. 7. Charts for t equal to over 2 in. to 4 in. (50 to 100 mm) inclusive

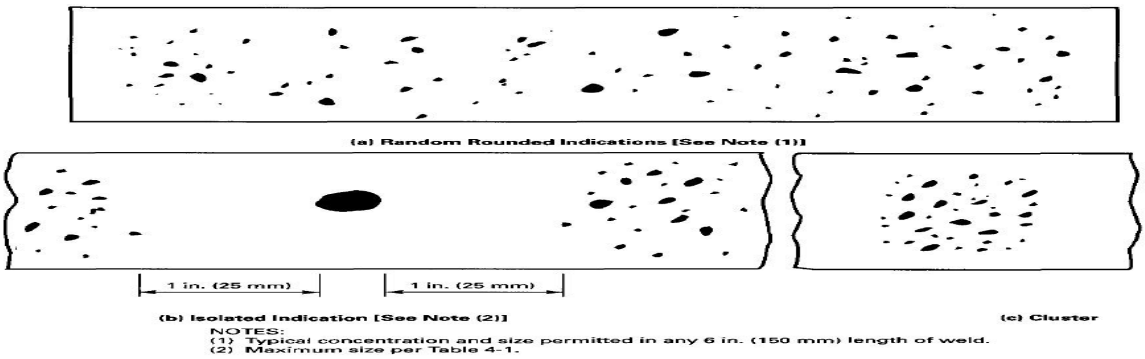


Fig. 15. 1. 8. Charts for t over 4 in. to 4 in. (100 mm) inclusive

II.f) Weld Thickness t less than 1/8 in(3mm)

For t less than 1/8 in.(3mm) the maximum number of rounded indications shall not exceed 12 in 6 in.(150mm) length of weld. A proportionally fewer number of indications shall be permitted in welds less than 6 in. (150mm) in length.

II.g) Clustered indications

The illustrations for clustered indications show up to four times as many indications in a local area, as that shown in the illustrations for random indications. The length of an acceptable cluster shall not exceed the lesser of 1 in. (25m) or 2t. Where more than one cluster is present, the sum of the lengths of the clusters shall not exceed 1in.(25mm) in a 6 in.(150mm) length weld.

32. DEFECT REMOVAL

16.1. All discontinuities in excess to acceptance standard shall be removed suitable means and repaired according to approved procedure.

16.2. The repaired area shall be radio graphed after repair accordance with this specification; the repeated film shall be identified with lead letter ”R”.

Thickness *t*, mm	Maximum Size of Acceptable Rounded Indication, mm		Maximum Size of Nonrelevant Indication, mm
	Random	Isolated	
Less than 3	1/4 *t*	1/3 *t*	1/10 *t*
3	0.79	1.07	0.38
5	1.19	1.60	0.38
6	1.60	2.11	0.38
8	1.98	2.64	0.79
10	2.31	3.18	0.79
11	2.77	3.71	0.79
13	3.18	4.27	0.79
14	3.61	4.78	0.79
16	3.96	5.33	0.79
17	3.96	5.84	0.79
19.0 to 50, incl.	3.96	6.35	0.79
Over 50	3.96	9.53	1.60

NOTE:
(1) This Table contains examples only.

Table 16.1: Maximum Size Of Acceptable Rounded Indication (mm)

33. REPORTS

Any radiographic examination shall be documented in a report made using the form shown in the Appendix 1.

This report shall include the following minimum information:

-Identification, job number,

-Isotope

-Material type and thickness range,

-Minimum source to film distances,

-Film brand and designation,

-Number of films per cassette,

-Single -or double-wall exposure,

-Single -or double-wall viewing.

The report shall be prepared and dated by the qualified and certified Level II who examined the evaluation and disposition of the radiographs and approved by the qualified and certified Level II or Level III who performed the final acceptance of the radiographs.

A report shall be prepared and furnished to the client. Report of Radiographic Examination will be used.

34-FILM STORAGE:

Exposed films shall be stored in accordance with ASME SEC V article2 Appendix3

35.0. PURPOSE

This procedure defines the methods of performance, the examination conditions and the precautions to be taken when an ultrasonic examination is carried out of Air cooled heat exchangers that will be procured in "**Toase-ehe Park Sanati Gohar Ofogh Petrochemical Co. CONCEPTUAL, BASIC and DETAIL DESIGN ENGINEERING OF STYRENE PARK OFFSITE** "

36.0. SCOPE AND APPLICABLE PARTS FOR TEST

This procedure is applicable for carry out testing on welded joints of header boxes of air cooled heat exchanger and materials, shapes, or sizes to be examined and the extent of examination are according to NDT. CHECK LIST & NDT MAP of project (EI027-DMF-VD-QC-PRO-023).

37.0. REFERENCES

37.1. ASME section VIII div.1 edition 2010 addendum 2011

37.2. ASME SEC.V-Last Edition

37.3 ANSI/ASME B31.3

38.0. DEFINITION

38.1. S.D.H Block: Side Drilled Hole block

38.2. D.A.C: Distance -Amplitude Correction

39.0. PERSONNEL QUALIFICATION

Operators shall be qualified and certified in accordance with SNT-TC-1A

All NDE shall be done by or under the supervision of personnel certified to SNT-TC-1A level II /III.

40.0. GENERAL REQUIREMENTS

40.1. Particular specifications

Each particular specification shall include at least the following information:

-Type of the material and/or of the weld to be examined including dimensions,

thickness and shape of the product,

-Surface(s) from which the ultrasonic examination is to be carried out,

-surface finish,

-Couplant to be used

-examination technique: straight beam, angle beam, contact and/or immersion,

-calibration description calibration blocks and calibration technique,

-directions and extent of scanning,

-information mentioned on examination report and recording method (manual or mechanized)

-Automatic alarm or recording equipment or both,

- Scanning mechanism; rotation, revolving, etc.

-Post-examination cleaning.

40.2. General examination requirements

40. 2.1. To assure a complete coverage of the whole area to be examined, each pass of the search unit shall overlap a minimum of 10% of the search unit width.

40.2.2. The rate of the search unit movement shall not exceed 150 mm / s.

41.0. EQUIPMENT USED

41.1. Frequency

Unless otherwise required in the particular examination specifications, the examination shall be conducted with pulse echo ultrasonic equipment capable of generating frequencies over the range of 1 to 5 MHz

41.2. Screen Height Linearity

The ultrasonic instrument shall provide linear vertical presentation within ±5 % of the full screen height for 20 % to 80 % of the calibrated screen height. The evaluation of the screen height linearity shall be performed before each period of extended use or at least every three months.

41.3. Amplitude Control Linearity

The ultrasonic instrument shall use an amplitude control accurate over its useful range to ± 20 % of the nominal amplitude ratio. The evaluation of the amplitude control linearity shall be performed before each period of extended use or at least every three months. (Accordance to ASME Sec.V Art.4)

41.4. Equipment calibration

The adequate calibration shall be carried out before and after each examination .when there is a change in operator and when bad functioning is suspected.

When bad functioning is established during calibration, all examinations carried out after the last valid calibration shall be reconducted.

41.5. Search Units

Search Units may contain either single or dual transducer elements.

42.0. WELD EXAMINATION

42.1. Calibration

a) V1 & V2 Standard Test block.

b) ASME Reference block (Side drilled hole ϕ=1.5)

c) The Material of Calibration shall be same P-No with base material

42.1.1. Calibration block for circular weld examination

For examination in materials where the examination surface diameter is greater than 500 mm (20in), a flat calibration block shall be used.

Otherwise the calibration block to be used shall be such as to calibrate examination on surfaces in the range of curvature from 0.9 to 1.5 times the calibration block diameter.

42.2. Technique

42.2.1. Angle beam calibration

The calibration shall include the following measurements:

a) Sweep range calibration on block V1

b) Distance- amplitude correction,

c) Position calibration (given directly by numeric equipment),

d) Echo amplitude measurement

The examination sensitivity shall be established at 80% of full screen height using the side drilled hole predicting the largest response. The distance amplitude correction (DAC) curve shall be constructed by utilizing the responses from the side drilled whole reflectors in the calibration block.

42.2.2. Straight beam calibration

The calibration shall include the following measurements:

- sweep range calibration on block V1

- Distance – amplitude correction

- echo amplitude measurement

Base metal:

The examination sensitivity shall be established at 75% of full screen height using the second back wall echo of the thickness examined.

Weld:

The examination sensitivity shall be established at 80% of full screen height using the side drilled hole predicting the largest response.

42.2.3. Non-Piping Calibration Block

42.2.3.1. Basic Calibration Block

The basic calibration block configuration and reflectors shall be as shown in next page .The block size and reflector locations shall be to perform calibrations for the beam angles used.

42.2.3.2. Block Thickness

When two or more base material are involved, the calibration block thickness shall be determined by the average thickness of the weld. Alternatively, a calibration block having the greater base material thickness may be used provided the reference reflector size is based upon the average or smaller weld thickness.

42.2.3.3. Block Range of Use

When the block thickness ±1 in (25mm) spans two weld thickness ranges as shown in

Fig. 1, the blocks use shall be acceptable in those portions of each thickness. As an example, a calibration block with a thickness of 1½in. (38mm) could be used for weld thicknesses of 0.5 in (13mm) to 2.5in (64mm)

42.2.3.4. TECHNIQUES FOR STRAIGHT BEAM CALIBRATIONS (Distance–Amplitude Correction

The following is used for calibration (see Fig.2)

(a) Position the search unit for the maximum indication from the SDH, which gives the highest indication.

(b) Adjust the sensitivity (gain) control to provide an 80% (±5%) of FSH indication. This is the primary reference

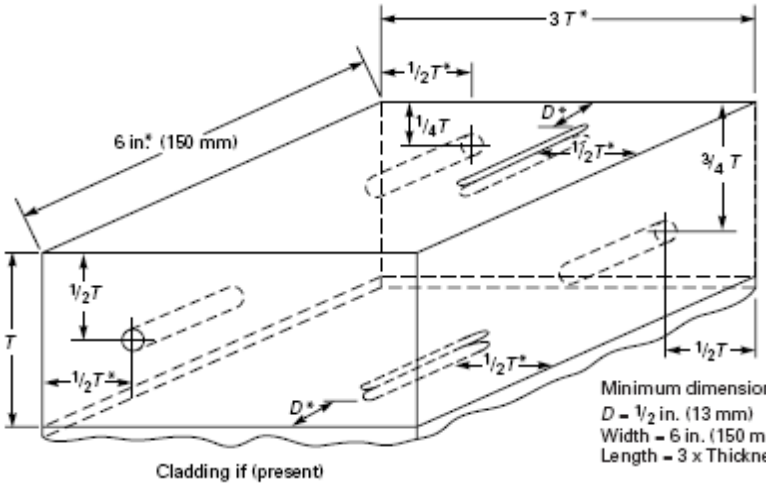
Level. Mark the peak of this indication on the screen.

(c) Position the search unit for maximum indication from another SDH.

(d) Mark the peak of the indication on the screen.

(e) Position the search unit for maximum indication from the third SDH and mark the peak on the screen.

(f) Connect the screen marks for the SDHs and extend through the thickness to provide the distance–amplitude curve.



Weld Thickness (t), in. (mm)	Calibration Block Thickness (T), in. (mm)	Hole Diameter, in. (mm)
Up to 1 (25)	3/4 (19) or t	3/32 (2.5)
Over 1 (25) through 2 (50)	1 1/2 (38) or t	1/8 (3)
Over 2 (50) through 4 (100)	3 (75) or t	3/16 (5)
Over 4 (100)	$t \pm 1$ (25)	[Note (1)]

Notch Dimensions, in. (mm)
Notch depth = 2% T
Notch width = 1/4 (6) max.
Notch length = 1 (25) min.

Figure 1. Non-Piping Calibration Block

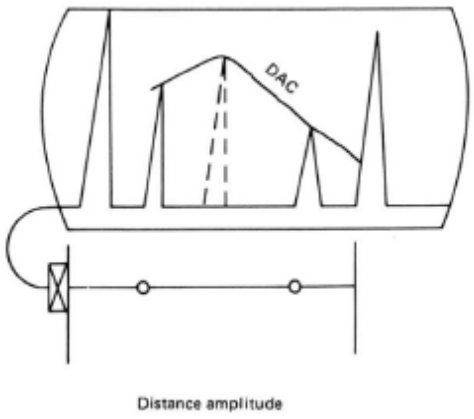


Figure 2. Distance–Amplitude Correction

42.2.4. Calibration for Piping

42.2.4.1. Calibration Block(s).

Calibrations shall be performed utilizing the calibration block shown in Fig. T-434.3.

42.2.4.2. Angle Beam Calibration.

The angle beam shall be directed toward the calibration reflector that yields the maximum response. The gain control shall be set so that this response is 80% ±5% of full screen height. This shall be the primary reference level. The search unit shall then be manipulated, without changing instrument settings, to obtain the maximum responses from the calibration reflectors at the distance increments necessary to generate a three-point distance-amplitude correction (DAC) curve.

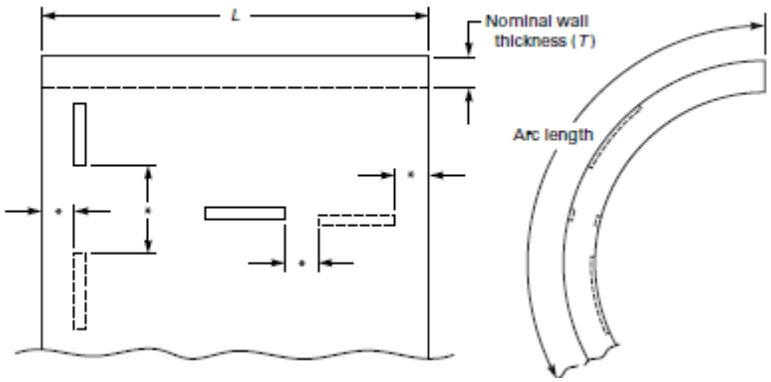
Separate calibrations shall be established for both the axial and circumferential notches. These calibrations shall establish both the distance range calibration and the distance amplitude correction.

Straight Beam Calibration. When required, straight beam calibrations shall be performed to the requirements of Nonmandatory Appendix C using the side-drilled whole alternate calibration reflectors of T-434.1.1. This calibration shall establish both the distance range calibration and the distance amplitude correction.

System Calibration for Non-Distance Amplitude Techniques. Calibration includes all those actions required to assure that the sensitivity and accuracy of the signal amplitude and time outputs of the examination system (whether displayed, recorded, or automatically processed)

are repeated from examination to examination. Calibration may be by use of basic calibration blocks with artificial or discontinuity reflectors. Methods are provided in Nonmandatory Appendices B and C. Other methods of calibration may include sensitivity adjustment based on the examination material, etc.

FIG. T-434.3 CALIBRATION BLOCK FOR PIPE



42.3. Calibration control

Calibration control shall be carried out each time the calibration block is to be used.

This control shall concern the sweeping speed and the distance amplitude curve.

A calibration control of at least one reflector of the calibration block shall be carried out at the end of each examination of series of similar tests, or every four hours or when there is a change in operator.

42.3.1. Sweep range correction

If a point of the DAC curve has moved on the sweep line more than 10 % of the sweep reading or 5 % of full sweep-whichever is greater correct the sweep range calibration and note the correction on the examination record.

If reflectors are recorded on the data sheets, a new calibration shall be recorded. All recorded indications since the last valid calibration or calibration check shall be reexamined with the corrected calibration and their values shall be changed on the date sheets.

42.3.2. DAC correction

If a point of the Distance -Amplitude Correction (DAC) curve has decreased 20 % or 2dB of its amplitude, all date sheets since the last valid calibration or calibration check shall be marked void. A new calibration shall be made and recorded and the area covered by the voided data shall be re-examined.

If any point of the DAC curve has increased more than 20 % or 2 dB of its amplitude, all recorded indications since the last valid calibration or calibration check shall be re-examined with the corrected calibration and their values shall be changed on the data sheets.

43. Surface preparation

43.1. Base Metal

The contact surfaces shall be free from weld spatter or any roughness which would interfere with the free movement of the search unit or impair the transmission of the ultrasonic waves in the part.

44.0. Examination

44. 1. Straight beam scanning

For weld examination using angle beam search unit, the volume of the adjacent base metal to be crossed by the ultrasonic waves shall be scanned with a straight beam search unit so as to detect reflectors that might affect the interpretation of angle beam results.

This precaution is not to be considered as an acceptance-rejection examination. Locations and areas of such reflectors shall be recorded.

The weld and base metal scanning shall be performed at a gain setting two times (at least) the primary reference level Evaluation shall be performed with respect to the primary reference level. Evaluation shall be performed with respect to the primary reference level.

44. 2 .Angle beam scanning for detecting reflectors oriented parallel to the weld

The angle beam shall be directed at approximate right angles to the weld axis from two directions where possible.

The search unit shall be manipulated laterally and longitudinally so that the ultrasonic waves pass through the weld and the adjacent base metal.

The scanning shall be performed at a gain setting two times (at least) the primary reference level. Evaluation shall be performed with respect to the primary reference level.

44.3. Angle beam scanning for detecting reflectors transverse to the weld

The angle beam shall be essentially directed parallel to the weld axis. The search unit shall be manipulated so that the ultrasonic waves pass through the whole weld and the base metal adjacent to it.

The scanning shall be performed at a gain setting two times the primary reference level. Evaluation shall be performed with respect to the primary reference level. The search unit shall be rotated in two directions 180 º and the examination repeated.

44.4. Ultrasonic System

Calibrations shall include the complete ultrasonic system and shall be performed prior to using

The system in the thickness range under examination.

44.5. Calibration Surface

Calibrations shall be performed from the surface (clad or unclad; convex or concave) corresponding to the surface of the component from which the examination will be performed.

44.6. Couplant

The same couplant to be used during the examination shall be used for calibration.

44.7. Contact Wedges

The same contact wedges to be used during the examination shall be used for calibration.

44.8. Instrument Controls

Any control which affects instrument linearity (e.g., filters, reject, or clipping) shall be in the same position for calibration, calibration checks, instrument linearity checks, and examination.

44.9. Temperature

For contact examination, the temperature difference between the calibration block and examination surfaces shall be within 25 %.

45.0. Evaluation

All indications producing a response greater than 20% of the reference level shall be investigated so as to evaluate the shape, identify and location of the reflectors in accordance with the acceptance criteria defined in Chapter 13.

46.0. ACCEPTANCE CRITERIA

a) The discontinuities are unacceptable if their amplitude exceeds the reference level and their length the following dimensions (Accordance to ASME SEC VIII Appendix 12):

- **6 mm for t ≤ 19 mm**
- **1/3 t for 19 < t ≤ 57 mm**
- **19 mm for t > 57mm**

*** t = thickness to be examined**

b) When discontinuities are interpreted to be cracks, lack of fusion or incomplete penetration, they are considered as unacceptable whatever their amplitude.

Repairs shall be re-examined according to this procedure.

47.0. EXAMNATION REPORT

The Examination Report (see Appendix 1) shall be generated, filed during five (5) years at least and shall contain the following information:

-all references, procedures and equipment used for examination so that the examination may be reconducted later on in the same conditions;

-reference of the conditions of equipment calibration;

-a sketch or drawing indicating the examined weld and the item / piece number;

-a record of repaired surfaces and results of the new examination; the report shall specify the location, the amplitude, the dimensions and the depth of the discontinuities below the surface and the classification.

Hydrostatic Test Procedure for Chiller

1. Scope

This procedure describes the way Farnikan Co. carries out Hydrostatic test of Heat Exchanger in according to applicable code and specifications. The Hydrostatic Test is carried out to verify tightness and stability of equipment against internal pressure.

2. Reference Code and Standards

Test shall be performed in accordance to ASME VIII Div.1

3. Description

3.1. Test Equipment

The test equipment comprises a manually operated test pump, a water tank & two pressure gauges. For the respective measuring range and suitable connection material (flanges, blind flanges, Vent and drain connections, covers, bolts, gaskets) to comply with test Requirements shall be supplied.

The calibration / test certificate form for relevant pressure gauges shall be attached to test report & the calibration expiry date must be valid.

3.2. Test Fluid

Test Fluid shall be fresh and clean and freshwater for the hydrostatic test. When carbon and low alloy steel materials are exposed to potable water, chloride content in the water shall be less than 50 ppm. In the case of stainless steel equipment or parts, the water shall have a maximum chloride content of 30 ppm @ PH 8. Hydrostatic test shall be done by water and at the temperature of at least 16°C above MDMT but not more than 48°C.

3.3. Safety Instruction

All flange connections shall be closed and relevant bolts to be tight before pressurizing. Repairs and rework are not allowed on pressurized equipment. If repairs are required, the test must be stopped & started again after repair work is completed.

3.4. Safety Zones

In case of test pressure less than 100 barg and test temperature greater than 48°C, staying in direct vicinity (2m zone) has to be avoided and for test pressure greater than 100 bar and less or equal to 350 bar, and test temperature greater than 48°C, the pressure test shall be carried out at a remote part of workshop, or the near vicinity (5 m zone) has to be barricaded by plastic strips and marked by information plates as danger zone and prohibited area.

3.5. Preparation for Pressure Test

Prior to starting the pressure test, the inner and outer and welded joint surface has to be cleaned from dust, rolling residues, dirt, oils, paint and other foreign material.

The pressure gauges must be installed that way the operating personnel can inspect it during pressurizing.

Each equipment shall be equipped with min. 2 Numerical calibrated gauges with their valid calibration test certificate is available. (i.e. one pair on the highest point and another pair on the lowest point.)

3.6. Consider the following Notes

-Dial indicating pressure gages used in testing shall be graduated over a range of about the intended maximum test pressure, but in no case shall the range be less than 1 ½ nor more than 4 times that pressure.

-The test pressure shall be read at the top of the equipment, erected as for operation.

-Vertical equipment shall be hydrostatically tested at horizontal position.

-Equipment has to be properly vented at the highest point.

-The gasket shall be of the same type and material as the service gasket for not removable connection.

- Service bolting shall be used for pressure testing. Bolt and nuts shall be thoroughly inspected after testing and replaced whenever damaged. This inspection shall be witnessed by the inspection agency.

3.7. Testing Process

A fully detailed testing procedure shall be submitted to the Purchaser for approval prior to

fabrication. The equipment shall be tested in the presence of the Inspection Agency, before being painted. Prior to testing, the equipment shall be thoroughly cleaned and free from dirt, debris, loose scale and slag, pieces of metal, weld spatter, oil and grease, etc.

- Tightness of welded attachments with telltale hole shall preliminarily be air and soapsuds tested.
- Service bolting shall be used for pressure testing; bolts and nuts shall be thoroughly inspected after testing and replaced whenever damaged. This inspection shall be witnessed by the Inspection Agency.
- Gaskets shall be the same as for the service type, dry or coated with graphite. Use of compounds, glue, lead, is not permitted. Rings gaskets shall be replaced after testing if damaged. All other gaskets shall be replaced with new ones after testing.

• All air shall be vented from the equipment before the pressure is applied.

• Test pressure shall be held at least one hour during visual examination of the equipment by the Inspection Agency.

All items should be tested according to Pressure Test Curve (Fig.1) and related pressure data(Table.1).

-The equipment shall be stand on suitable condition pressurized slowly and gradually to the half of the design pressure according to pressure schedule table. The holding time for a visual check at this stage is minimum 15min.

- The pressure shall be increased to design pressure and inspection shall be accomplished. The holding time for this stage is minimum 15 min.
- The pressure shall be increased to test pressure and a complete visual check for all connections (such as flanges, blind flanges, vent and drain connections, covers, bolts, gaskets) and weld joints shall be done for determining leakages or deformation. Hydrostatic test pressure shall normally be maintained for 1 hour. Then test pressure shall be decreased slowly and gradually to the 2/3 test pressure and inspection shall be accomplished. The holding time for this stage is minimum 15 min.
- After hydro testing the vent valve shall be gradually opened. After ensuring this valve is fully opened, the drain valve shall be slowly opened. At this stage care must be taken to avoid any vacuum in Equipment due to waters draining.
- For protection and preservation of corrosion after hydro testing, equipment must be fully drained.

- Both heat exchangers have been pressure tested .

4.Acceptance Criteria

-During the holding time, the test pressure shall not fall below the required value.

-A deformation of the pressure retaining parts into the plastic region (permanent deformation) is not allowed.

-If leakages are found at the weld joints, repairs shall be performed according to code and spec. All repair works shall be subject to approval by TPI and inspection shall be repaired and re-hydrostatic tested.

5. Pneumatic Test

Pneumatic test for reinforcing pads shall be done in following conditions:

- Dial indicating pressure gages used in testing shall be graduated 5 Bar.
- The calibration / test certificate form for relevant pressure gauges shall be attached to test report.
- Test pressure: 2 barg
- Test media: Compressed air
- Holding Time: 5 Min
- All reinforcing pads for nozzles (welds of each pad or segment) shall be air tested at 2barg. Afterwards, the pressure must be reduced to 0.5 barg and all welds must be tested for leaks with soap solution. Vent holes will be left open after testing. After hydro-test, the holes must be filled with stiff grease and plugged.

6. Documentation

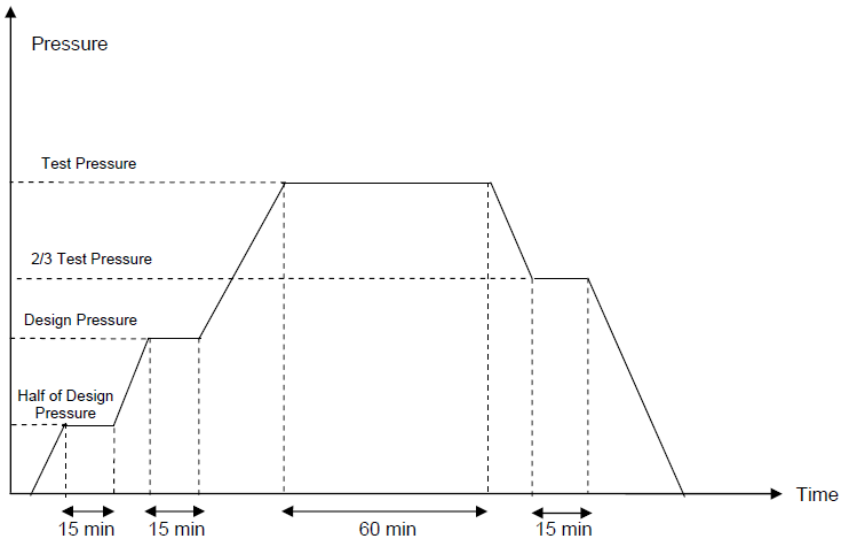
After satisfactory performance of pressure test, the hydrostatic test report shall be approved and signed by relevant inspectors (according to inspection test plan).

Table 1. Pressure Schedule

Table 1. Pressure Schedule

ITEM NO.	DESIGN PRESSURE (barg)		TEST PRESSURE (barg)	
	Shell Side	Tube Side	Shell Side	Tube Side
EVAPORATOR	22	6.8	28.6	8.84

Fig. 1: Hydrostatic Test Curve



NOTE: Increasing/decreasing Pressure rating should not be greater than 5 bar/min.

NDT Procedure (RT, UT, PT, MT) for Chiller

CONTENTS

RADIOGRAPHY EXAMINATION PROCEDURE

1) SCOPE

This article contains methods and requirements for Radiographic Examination of Heat Exchanger applicable when specified by NDT/Welding map.

2) REFERENCE

- ASME Sec. V, Article 2 & Article 22 (2019 Edition)
- ASME Sec. VIII Div.1 & Div.2 (2019 Edition)
- ASME Sec. IX (2019 Edition)

3) EXTENT OF PROCEDURE

- Examination of all Butt-weld Joints According to regarding Welding Map & ITP.
- Evaluation by contractor or Third Party Inspector shall be done according to the relevant Project Specification requirements / Approved ITP.

4) SURFACE PREPARATION

All welded joint shall be visually inspected before commencement of any non-destructive examination also the requirement of ASME Sec. V, Para. T.222 for surface preparation shall be met. Any irregularities that can mask or be confused with discontinuities shall be removed by any suitable process to a degree that the applicable material Spec. the referencing code and the other requirements.

5) DENSITOMETER

5.1) Densitometers shall be calibrated at least every 90 days during use as follows:

a) A national standard step tablet or a step wedge calibration film, traceable to a national standard step tablet and having at least 5 steps with neutral densities from at least 1.0 through 4.0, shall be used.

The step wedge calibration film shall have been verified within the last year by comparison with a national standard step tablet.

b) The densitometer manufacturer’s step-by-step instruction for the operation of the densitometer shall be followed.

c) The density steps closest to 1.0, 2.0, 3.0, and 4.0 on the national standard step tablet or step wedge calibration film shall be read.

d)The densitometer is acceptable if the density readings do not vary by more than ±0.05 density units from the actual density stated on the national standard step tablet or step wedge calibration film.

5.2) Periodic Verification

Periodic calibration verification checks shall be performed as described in 5.1 at the beginning of each shift, after 8 hr of continuous use, or after change of apertures, whichever comes first.

5.3) Documentation

Densitometer calibrations required by 5.1 shall be documented, but the actual readings for each step do not have to be recorded. Periodic densitometer verification checks required by 5.2 do not have to be documented.

5.4) Traceability

All film shall be traceable

6) FACILITIES FOR VIEWING FILM

(a) Viewing facilities shall provide subdued background lighting of an intensity that will not cause reflections, shadows, or glare on the radiographs that interfere with the interpretation process. Equipment used to view radiographs for interpretation shall provide a variable light source sufficient for the essential IQI designated wire to be visible for the specified density range. The viewing conditions shall be such that light from around the outer edge of the radiograph or coming through Low-density portions of the radiograph do not interfere with interpretation.

(b) To provision of best viewing condition, the illuminator must provide sufficient light of an intensity that will illuminate the average density. (1.8 minimum for single film viewing for radiographs made with an X-ray source and 2.0 minimum for radiographs made with a gamma ray source).

Viewing conditions shall be such that the light transmitted from the outer edges of the film or low-density region does not interfere with the interpretation of the radiograph. Subdued lighting rather than total darkness is preferable in the viewing room. The brightness of the surrounding should be about the same as the area of interest in the radiograph. Room illumination must be so arranged that there are no reflections from the surface of the film under examination.

(c) Identification markers:

-The permanent identification (see attachment) shall be produced on the radiograph traceable to the contract, component, weld seam, or part number, as appropriate. In any case this information shall not obscure the area of interest. Repair or reshoot radiographs shall be identified by R1, R2, R/S, as applicable.

-For composite viewing of multiple film exposures, each film of the composite set shall have a minimum density of 1.3. The maximum density shall be 4.0 for either single or composite viewing. A tolerance of 0.05 in density is allowed for variations between densitometer readings.

-The identification marks will be appeared on the radiographs and will not interfere with the image. It will include, project identification equipment Tag No., Weld line, welder stamp and date of testing as a minimum.

7) GEOMETRIC UNSHARPNESS

7.1) GEOMETRIC UNSHARPNESS DETERMINATION

Geometric un sharpness of the radiograph shall be determined in accordance

with: $Ug = Fd/D$

Where

Ug= geometric unsharpness

F= source size: maximum projected dimension of the radiating source (or effective focal spot) in the plane perpendicular to the distance D from the weld or object radiation, in.

D= distance from source of the radiation to weld or object being radiographed, in.

d= distance from source side of weld or object being radiographed to the film D and d shall be measured to the approximate center of the area of interest.

7.2) The actual or maximum source size (effective focal spot size) and source to film distance shall be recorded in the report, and the geometric unsharpness shall meet the requirements of 7.3.

7.3) GEOMETRIC UNSHARPNESS LIMITATIONS

Recommended maximum values for geometric un-sharpness are as follows:

Material Thickness, mm	Ug Maximum, mm
Under 50	0.51
50 through 75	0.76
Over 75 through 100	1.02
Greater than 100	1.78

Note: Material thickness is the thickness on which the IQI is based.

8) RADIATION SOURCE

Radiation source is Iridium 192 and maximum source size is 2x3 mm.

9) TECHNIQUE

SWSI source-weld-film arrangement shall be indicated as per ASME Sec. V. Double wall exposure shall be used just when single wall exposure is not applicable. Care should be exercised to ensure that the required geometric un-sharpness is not exceeded. If the geometric un-sharpness requirement cannot be met for double wall viewing technique, then single wall viewing shall be used (If applicable).

10) EQUIPMENT

Gamma-ray apparatus (sentinel) with remote control or equivalent.

Note: The minimum and maximum thickness for the use of radioactive isotopes is primarily dictated by exposure time that the required radiographic sensitivity has been obtained.

11) FILM TYPE

- Radiographic inspection performed using Fine grain film, D7, D4 (Type 1 and 2) or equivalent. Radiographic film length shall be 250 mm (10 inches) minimum. Film width shall be minimum 100 mm where accessible.

-The film treatment shall be in accordance with the film supplier recommendation.

12) INTENSIFYING SCREEN

- Back & front lead screens 0.13 mm thick
- Fluorescent intensifying screen shall not be used
- Lead intensifying screen shall be in direct contact with the film
- Prepakced films may be used

13) EXPOSURE CONDITION

Depending on diameter & wall thickness, minimum source to film distance shall be 200 mm. For using of radioactive isotopes the recommendation of ASME Sec. V Article II, part T-272 shall be considered.

14) NUMBER OF EXPOSURE

Minimum 3 Exposures takan120°, to each other shall be made. For welds on nozzles with nominal diameter 3" or less, may be performed by the elliptical projection technique. At least two separate exposures are required at location 90° apart.

15) OVER LAP

30 mm on each side of film may be used.

16) PENETRAMETER

Wire type and material according to ASTM E747. The Penetrometer shall be set at the end of film location. The Penetrometer shall be placed on the welds (on film side) so that the wire is perpendicular to the welds.

17) BACK SCATTER RADIATION

A lead symbol “B,” with minimum dimensions of 13 mm in height and 1.5 mm in thickness, shall be attached to the back of each film holder during each exposure to determine if backscatter radiation is exposing the film.

18) SENSITIVITY

Radiography shall be performed with a technique and radiographic set up which ensures achievement of the required Quality level and shall be calculated as per related standard or Project specification.

Calculation of Equivalent Pentameters sensitivity (EPS)

18.1) For set up hole type IQI

EPS = 100 x Square root of (T x h/2) / X

X = thickness to be radio graphed

T = thickness of the designated IQI

H = diameter of visible hole

18.2) Wire type IQI

EPS = D x 100 / X

Where X = thickness to be radio graphed

D = diameter of thinnest wire visible as a radiographic image.

19) FILM DENSITY

The calibration of densitometer is considered valid as long as the unit is not switched off during a series of measurement. Film density shall be according to ASME Sec. V, Article II-Part-T-282. & shall be limited to viewer capacity 2 to 3.5

20) FILM PROCESSING

- Type: Manual Agfa gravity G 127 or equivalent.
- Developing bath
- Developing temperature around 20ºC (approximately 5 minutes).
- Agfa gravity G 335 or equivalent.
- Fixing bath: Fixing time 10 minutes (approximately 20ºC).
- Washing: In running water + melting agent.
- Drying: Using suitable drier.
-Viewing: Light intensity adjustable viewer suitable to view 1.8 to 4.

21) LOCATION MARKS

Location markers,(Fig.T-275 of ASME Sec V Article 2) ,which are to appear as radiographic images on the film, shall be placed on the part, not on the exposure holder /cassette ,Their locations shall be permanently marked on the surface of the part being radio graphed when permitted, or on a map, in a manner permitting the area of interest on a radiograph to be accurately traceable to its location on the part, for the required retention period of the radiograph .Evidence shall also be provided on the radiograph that the required coverage of the region being examined has been obtained.

22) IDENTIFICATION AND MARKING OF RADIOGRAPHS

Each film shall be identified as per following items to avoid any confusion and mismatching in the reports and relevant films. Marking shall clear the outer edges of the weld.

1) Project identifier manufacture name
2) Column No.
3) Joint No.
4) Welder Stamp
5) Weld Thick
6) Location Mark
7) Pentameter
8) Date of Shooting

9) XR No.

10) Weld number

11) Identification of Shooting Status (Repair: R1, Retake: RT, Reshoot: RS...)

12) After P.W.H.T with "AP"

23) ACCEPTANCE CRITERIA

For acceptance interpretation of weld the requirements of ASME Sec. VIII Div.1, Appendix 4, UW-51 & UW-52 shall be followed. Imperfections listed in above criteria are unacceptable shall be repaired as provided in UW-38 and the repair re-examined.

(a) Image Density. Density within the image of the indication may vary and is not a criterion for acceptance or rejection.

(b) Relevant indications. Only those rounded indications which exceed the following dimensions shall be considered relevant.

(1) 1/10 t for t less than 3 mm.

(2) 1/64 in. for t from 3 mm to 6 mm

(3) 1/32 in. for t greater than 6 mm to 50 mm

(4) 1/16 in. for t greater than 50 mm

(c) Maximum Size of Rounded Indication. The maximum permissible size of any indication shall be 1/4 t, or 4mm,whichever is smaller; except than an isolated indication separated from an adjacent indication by 25mm or more may be 1/3 t, or 6 mm, whichever is less.

For t greater than 50mm the maximum permissible size of an isolated indication shall be increased to 10mm.

(d) Aligned Rounded Indications. Aligned indications are acceptable when the summation of the diameters of the indications is less than t in a length of 12t. See Fig.1-1. The length of groups of aligned rounded indications and the spacing between the groups shall meet the requirements of Fig.1-2.

(e) Spacing. The distance between adjacent rounded indications is not a factor in determining acceptance or rejections, except as required for isolated indications or groups of aligned indications.

(f) Rounded Indication Charts. The rounded indications characterized as imperfections shall not exceed that shown in the charts. The charts in Figs.1-3 through 1-8 illustrate various types of assorted. Randomly dispersed and clustered rounded indications for different weld thicknesses greater than 3mm. These charts represent the maximum acceptable concentration limits for rounded indications.

The charts for each thickness range represent full-scale 150mm radiographs, and shall not be enlarged or reduced. The distributions shown are not necessarily the patterns that may appear on the radiograph, but are typical of the concentration and size of indication permitted.

(g) Weld Thickness t less than 3mm. For t less than 3mm the maximum number of rounded indications shall not exceed 12 in a 150mm length of weld. A proportionally fewer number of indications shall be permitted in welds less than 150mm in length.

(h) Clustered Indications. The illustrations for clustered indications show up to four items as many indications in a local area, as that shown in the illustrations for random indications. The length of an acceptable cluster shall not exceed the lesser of 25mm or 2t, where more than one cluster is present. The sum of the lengths of the clusters shall not exceed 25mm in a 150mm length weld.

(I) Elongated indication:

a) any indication characterized as a crack or zone of incomplete fusion or penetration is unacceptable

(1) Any other elongated indication on the radiograph which has length greater than: (a)1/4 in.(6mm) for t up to 3/4 in.(19mm)

(b)1/3 t for t from 3/4 in.(19mm) to 2 1/4 in. (57mm)

(c)3/4 in.(19mm) for t over 2 1/4 in.(57mm)

Where

t = the thickness of the weld excluding any allowable reinforcement. For a butt weld joining two members having different thicknesses at the weld.t is the thinner of these two thicknesses. If a full penetration weld includes a fillet weld. the thickness of the throat of the fillet shall be included in t.

(2) Any group of aligned indications that have an aggregate length greater than t in a length of 12 t, except when the distance between the successive imperfections exceeds 6L where L is the length of the longest imperfection in the group.

Table 1: Acceptable Indication

SI Units

Thickness t, *mm*	Maximum Size of Acceptable Indication ,mm		Maximum Size of Non-relevant Indication ,mm
	Random	Isolated	
Less than 3	1/4 t	1/3 t	1/10 t
3	0.79	1.07	0.38
5	1.19	1.60	0.38
6	1.60	2.11	0.38
8	1.98	2.64	0.79
10	2.31	3.18	0.79
11	2.77	3.71	0.79
13	3.18	4.27	0.79
14	3.61	4.78	0.79
16	3.96	5.33	0.79
17	3.96	5.84	0.79
19.0 to 50 ,incl.	3.96	6.35	0.79
Over 50	3.96	9.53	1.60

J)Acceptance Criteria of Spot Radiography

b) The acceptability of welds examined by spot radiography shall be judged by the following standards:

(1) Welds in which indications are characterized as cracks or zones of incomplete fusion or penetration shall be unacceptable.

(2) Welds having indications characterized as slag inclusions or cavities are unacceptable when the indication length exceeds 2/3*t* .

c) For all thicknesses, indications less than 1/4 in. (6 mm) are acceptable, and indications greater than 3/4 in. (19 mm) are unacceptable. Multiple aligned indications meeting these acceptance criteria are acceptable when the sum of their longest dimensions indications does not exceed *t* within a length of 6*t* (or proportionally for radiographs shorter than 6*t*), and when the longest length *L* for each indication is separated by a distance not less than 3*L* from adjacent indications.

(3) Rounded indications are not a factor in the acceptability of welds not required to be fully radiographed.

24) EXAMINATION REPORT

Attached form will be used to record examination results.

25) PERSONNEL QUALIFICATION

All operators, must be qualified to SNT-TC-1A level I, European norm: EN 473 entitled "Qualification and Certification of NDT Personnel" As a minimum, Interpretation must be carried-out by inspectors holding at least Valid Certificate to SNT-TC-1A level II, European norm: EN 473 entitled "Qualification and Certification of NDT Personnel" or CSWIP.

General Note:

All welded joint shall be visually inspected before commencement of any Non Destructive examination.

26) REPORTING

Operator/Interpreter shall provide a test report (attachment No. 1) after test Performing and film interpretation and give it to client authorized inspector for review &Approval.

All related document/ instruments shall be available to inspectors to be peer reviewed as their request. Also, they are allowed to challenge the interpretation and request additional/repeat NDE at their

discretion.

27) FILM STORAGE

Exposed films shall be stored in accordance with ASME SEC V article2 Appendix3 standard.

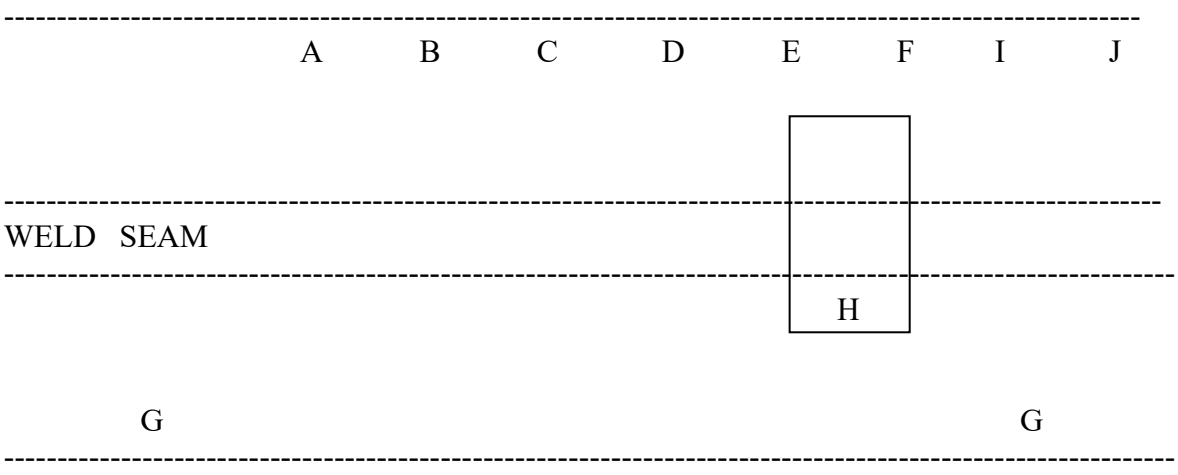
28) SAFETY SYSTEM

All safety items shall be performed according to Company rules by RT operators.

29) DOCUMENTATION

Vendor shall prepare and document the radiographic technique details and a radiograph review form. Each radiograph shall be documented on the radiographic examination report. As a minimum, the report shall include required information, described in Article 2, T- 291, ASME sec. V. The report shall be prepared and dated by the qualified and certified Level II who examined the evaluation and disposition of the radiographs and approved by the qualified and certified Level II or Level III who performed the final acceptance of the radiographs.

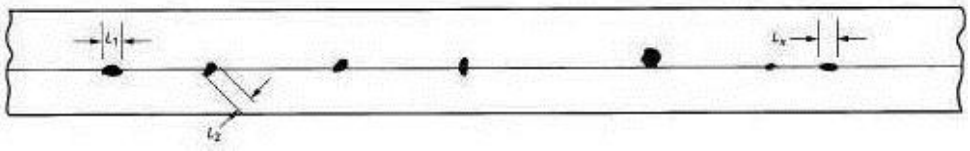
DENTIFICATION SYSTEM



A: Project identifier manufacture name
B: Item No.
C: Joint No.
D: Welder Stamp
E: Weld Thick
F: Date of Shooting
G: Location Mark
H: Penetrameter
I: Identification of Shooting
J: After PWHT

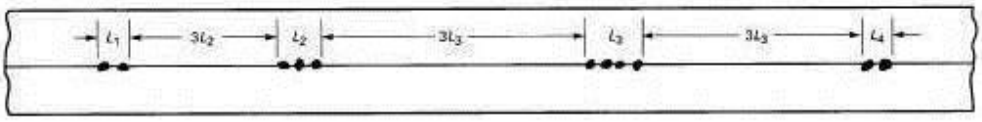
Note:
Arrangements of identification markers above are not necessarily in order.

Fig.1-1 Aligned Rounded Indications



Note: Sum of L_1 to L_X shall be less than *t* in a length of 12*t*.

Fig.1-2 Groups of Aligned Rounded Indications



Note: Sum of the group lengths shall be less than *t* in a length of 12*t*.

Maximum Group Length
L = ¼ in. (6mm) for t less than ¾ in. (19mm)
L = 1/3t for t3/4 in. (19mm) to 2 ¼ in. (57mm)
L = ¾ in. (19mm) for t greater than 2 ¼ in. (57mm)

Maximum Group Spacing
3L where L is the length of the longest adjacent group being evaluated.

Fig 1-3 Charts for t equal to 1/8 in. to 1/4 in. (3 mm to 6 mm), Inclusive

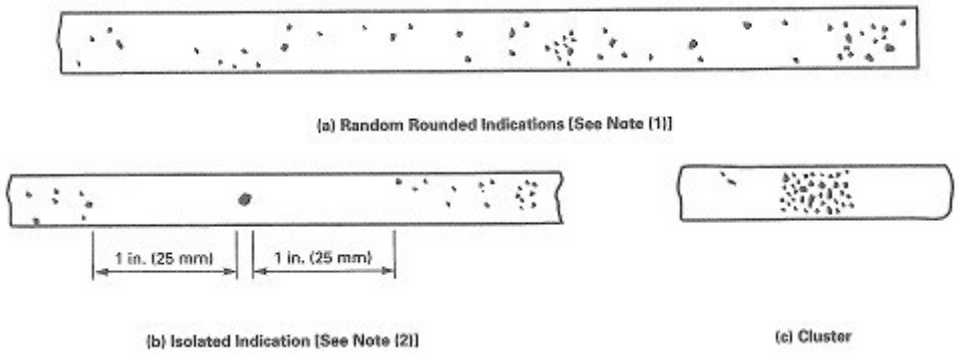


Fig 1-4 Charts for t over to 1/4 in. to 3/8 in. (6 mm to 10 mm), Inclusive

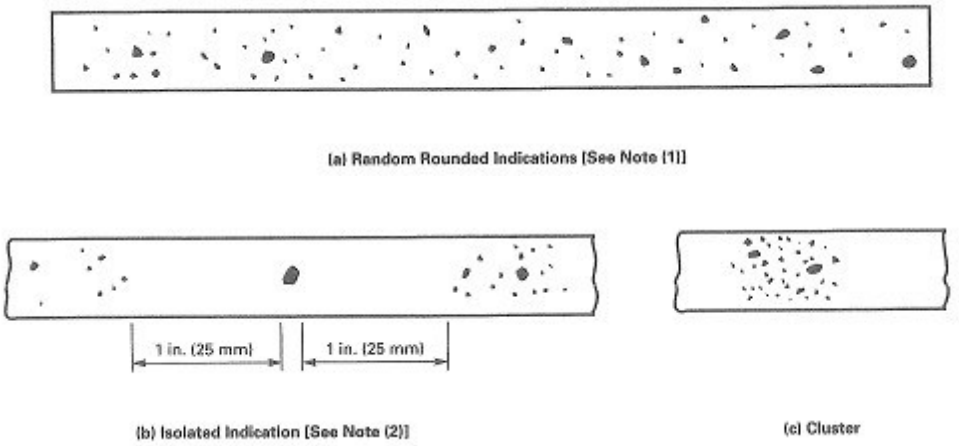


Fig 1-5 Charts for t over 3/8 in. to 3/4 in. (10 mm to 19 mm), Inclusive

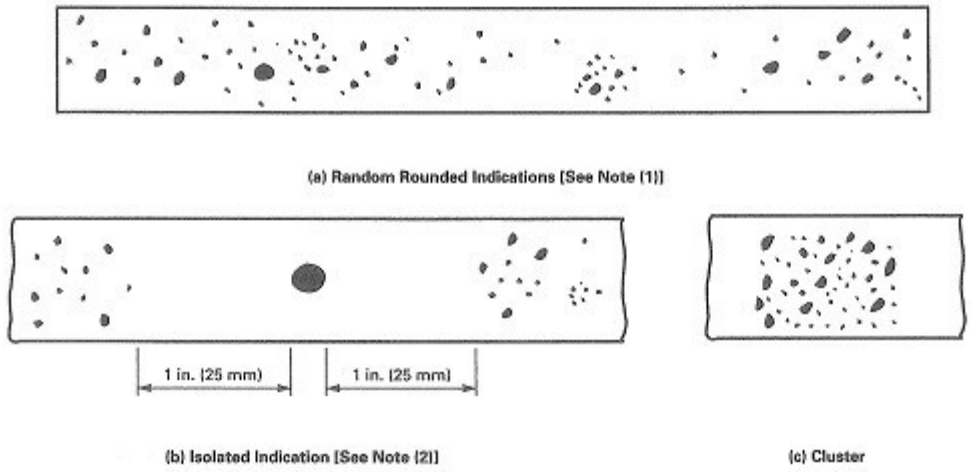
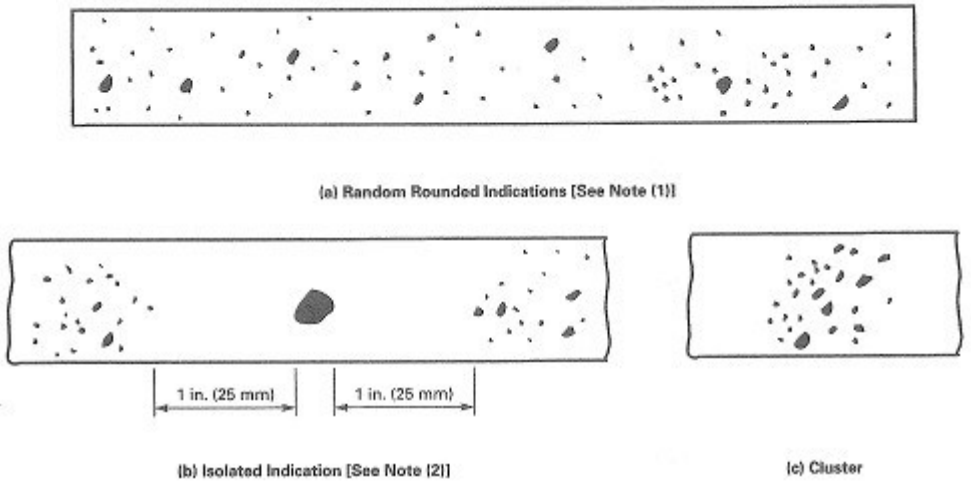
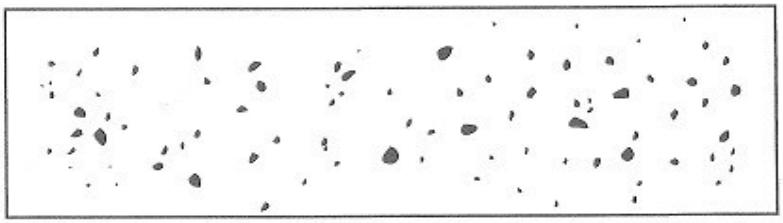


Fig.1-6 Charts for t over 3/4 in. to 2 in.(19 mm to 50 mm),Inclusive

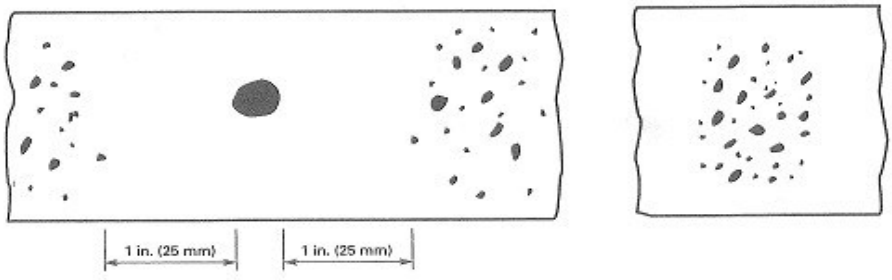


ig.1-8 Charts for t over 4 in. (100 mm)



(a) Random Rounded Indications [See Note (1)]

Fig.1-8 Charts for t over 4 in.(100 mm)



(b) Isolated Indication [See Note (2)]

(c) Cluster

NOTES:
(1)Typical concentration and size permitted in any 6 in. (150 mm) length of weld.
(2) Maximum size per Table 1

LIQUID PENETRANT

EXAMINATION PROCEDURE

Contents

1) SCOPE

This article contains methods and requirements for Liquid Penetrant Examination of Heat Exchanger applicable when specified by NDT map.

2) REFERENCE

- ASME V, Article 6 (2019 Edition)
- ASME VIII Div.1, App. 8 (2019 Edition)
- ASNT-TC-1A (Latest Edition)

3) TECHNIQUE

The technique used in this procedure is Color Contrast Penetrant, using solvent removable penetrant.

4) RAW MATERIAL

Brand name of PT set is BYCO TEST or equivalent. Penetrant, developer and cleaner shall have same brand name. Comparison block for each batch of liquid penetrant test, and also ARB block should be prepared.

5) SURFACE PREPARATION

Surface preparation by grinding, machining or other methods may be necessary where surface irregularities could mask indication. The surface to be examined (within at least 25 mm) shall be clean and free of grease, flux spatter, rust oil that might interfere with the penetration of liquid. Also the surface must be dried by proper method such as heating or using clean clothes in case of moisture or wet surface. The proper solvent for degreasing is BYCO TEST or equivalent.

6) LIQUID PENETRANT APPLICATION

- Type of dye penetrates is visible penetrant examination method.
- Apply by thoroughly and uniformly spraying on the part to be examined.
- The temperature of the penetrant and the surface of the part to be processed shall not be below 5°C not above 52°C throughout the examination period and when it is not practical to conduct a liquid penetrant examination within the temperature range of 5°C to 52°C, the examination procedure at the

proposed lower or higher temperature range requires qualification of the penetrant materials and processing in accordance with Mandatory Appendix III of Article 6 of ASME Sec V.

- The maximum penetration time according to table 672 of ASME Sec V. for temperature range from 10°C to 52°C for penetrant is 5 min and for developer is 10 min.

7) METHOD OF REMOVING EXCESS PENETRANT

Removing will be performing by special solvent and clean clothes (Magna flux SKC-S or equivalent). Solvent shall not be spray directly to the weld. Residual total chlorine (hydrogen, fluorine) sulfur shall not exceed 0.1 percent by weight. Method of drying surface after excess penetrant removal is commonly normal evaporation. The drying time shall be minimum 2 minutes and not be greater than 5 minutes. After the specified penetration (dwell) has elapsed, any penetrant remaining on the surface shall be removed, taking care to minimize removal of penetrant from discontinuities. Flushing the surface with solvent, following the application of the penetrant and prior to developing, is prohibited

8) DEVELOPING

The developer shall be applied as soon as possible after penetrate removal. The time interval shall not exceed that established in this procedure. Insufficient coating thickness may not draw the penetrant out of discontinuities; converse, excessive coating thickness may mask indications. With color contrast penetrates, only wet developer shall be used. With fluorescent penetrates, a wet or dry developer may be used.

8.1) WET DEVELOPER APPLICATION

Prior to applying suspension type wet developer to the surface, the developer must be thoroughly agitated to ensure adequate dispersion of suspended particles.

(a) Aqueous Developer Application. Aqueous developer may be applied to either a wet or dry surface. It shall be applied by dipping, brushing, spraying, or other means, provided a thin coating is obtained over the entire surface being examined. Drying time may be decreased by using warm air, provided the surface temperature of the part is not raised above 125˚F. Blotting is not permitted.

(b) Non aqueous Developer Application. Non aqueous developer shall be applied only to a dry surface. It shall be applied by spraying, except where safety or restricted accesses preclude it. Under such conditions, developer may be applied by brushing. Drying shall be by normal evaporation.

8.2) Developing time for final interpretation begins immediately after the application of a dry developer as soon as a wet developer coating is dry. The minimum developing time shall be 10 min.

9) EVALUATION OF EXAMINATION

Final interpretation shall be made within 10 to 60 min after the requirements of procedure are satisfied. The light intensity shall be 1000 lux light. All relevant indications shall be recorded and evaluated as per ASME sec. VIII Div. 1 appendix 8, Repair shall perform under supervision of inspector. Attached form will be used for examination report.

All related document/ instruments shall be available to inspectors to be peer reviewed as their request. Also, they are allowed to challenge the interpretation and request additional/repeat NDE at their discretion.

10) POST CLEANING

Post-examination cleaning shall be performed as soon as possible after the examination. Solvent or water, as applicable, shall be used to remove the residual penetrant and developer by spraying, wiping with cloths, or brushing.

11) PERSONNEL QUALIFICATION

All operators (Assistants) must be qualified to SNT-TC1A level I or level II. As a minimum, interpretation must be carried-out by inspectors holding at least valid certificate to ASNT-TC-1A level II.

12) PROCEDURE QUALIFICATION

When procedure qualification is specified, a change of requirement in an essential variable from the specified value, or range of values, shall require re-qualification of the written procedure

13) ACCEPTANCE CRITERIA

The acceptance criteria for above mentioned method will be according to ASME Sec. VIII Appendix 8 (Edition2019), are as below:

All surfaces to be examined shall be free of:

a) relevant linear indications
b) relevant rounded indications greater than 5 mm

c) four or more relevant rounded indications in a line separated by 1.5 mm or less (edge to edge).

d) Under cut of welds shall not exceed 0.3 mm

ULTRASONIC EXAMINATION PROCEDURE

Contents

1) SCOPE

1.1. This article contains methods and requirements for Ultrasonic Examination of Heat Exchanger applicable in materials whose section is 6 mm thick or greater when specified by NDT map. Technique details for specific contracts are given on the relevant procedure/Technique sheets and may not be subsequently revised with this document.

1.2. The examination of 'T,' 'Y,' 'K' welds, nozzle and node welds may be subject to severe restrictions to the extent of the ultrasonic scanning which is possible, as a result of the shape, position or angle of the joining members.

1.3. Such areas of restricted scanning, or restricted weld coverage must be recorded on the Inspection report.

2) REFERENCES

- ASME Sec. V, Article 4 (2019 Edition)
- ASME Sec. VIII Div.1 & Div.2 (2019 Edition)
- ASNT-TC-1A (Latest edition)
- BS EN 12223. 2000, NDT: Ultrasonic Examination - Specification for Calibration Block No. 1
- BS EN 27963: 1992, Specification for Calibration Block No. 2 for Ultrasonic Examination of welds.

3) QUALIFICATION OF PERSONNEL

All operators (assistants), must be qualified to SNT-TC1A level II, European norm: EN473 entitled "Qualification and Certification of NDT Personnel" As a minimum, Interpretation must be carried- out by inspectors holding at least Valid Certificate to SNT-TC-1A level II, European norm: EN 473 entitled "Qualification and Certification of NDT Personnel" or CSWIP. Utilization of other approval schemes is permitted by prior agreement between contracting parties and the scheme agreed upon shall be defined in the specific Technique/Procedure Sheets.

4) EQUIPMENT AND MATERIALS

4.1. Flaw Detector

The flaw detector shall be the Krautkramer USK6, USK7, USM35, Sonatest, Sitescan 110, Sitescan 130, Masterscan 330 or equivalent Company Approved equipment (by an appropriately qualified Member of Senior Management), calibrated accordance with the requirements of ASME V Article 5, T-530.

The equipment used must be calibrated at least each 3 mouths for linear vertical presentation (screen high linearity) and also for amplitude control linearity.

4.2) Probes

The probes to be used shall be selected from to the following. All probes shall be ESI rated.

Normal probes (Compression) 5.0MHz

10mm dia. Twin crystal. 4 MHz 24mm

dia. Single crystal 4 MHz 10mm dia.

Single crystal

d) Angle Probes (Shear)

AP4MHz 20mm Dia.	45°, 60°, 70°	38° (where applicable)
MAPS 4MHz 10mm Dia.	45°, 60°, 70°	38° (where applicable)
TMAPF 4MHz 10mm Dia.	45°, 60°, 70°	38° (where applicable)

4.3 Calibration Blocks

4.3.1. The appropriate Calibration Block with thicknesses and holes sizes in accordance with Article 5 Figures T-542-2.1 where side drilled holes are used. The calibration block shall be selected for the material thickness under examination.

4.3.2. IIW-V1 Calibration Block

IIW-V2 Calibration Block

4.3.3 Reflectors.

Specified reflectors (i.e., side-drilled holes, flat bottom holes, notches, etc.) shall be used to establish primary reference responses of the equipment. An alternative reflector(s) may be used provided that the alternative reflector(s) produces a sensitivity equal to or greater than the specified reflector(s) (e.g., side-drilled holes in lieu of notches, flat bottom holes in lieu of side- drilled holes).

4.3.4 Material

(a) Similar Metal Welds. The material from which the block is fabricated shall be of the same product form and material specification or equivalent P-Number grouping as one of the materials being examined. For the purposes of this paragraph, P-Nos. 1, 3, 4, 5A through 5C, and 15A through 15F materials are considered equivalent.

*(b)*Dissimilar Metal Welds. The material selection shall be based on the material on the side of the weldfrom which the examination will be conducted. If the examination will be conducted from both sides,calibration reflectors shall be provided in both materials.

4.3.4 Quality. Prior to fabrication, the block material shall be completely examined with a straight beam search unit. Areas that contain an indication exceeding the remaining back-wall reflection shall be excluded from the beam paths required to reach the various calibration reflectors.

4.3.5. Surface Finish. The finish on the scanning surfaces of the block shall be representative of the scanning surface finishes on the component to be examined.

4.4. Couplant

4.4.1. Conventional Couplant

The couplant shall be a proprietary ultrasonic couplant, a suitable cellulose based wallpaper adhesive, e.g. Polycell, oil or water as appropriate.

4.4.2. Halogen Free Couplant

Certain high alloy materials intended for use at elevated temperatures demand the use of halogen free couplants. In such circumstances only couplants certified as being Sulphur and Halogen free, (i.e. less than 50 ppm) shall be used.

"Couplants used on austenitic stainless steel or titanium shall not contain more than 250 ppm of halides (chlorides plus fluorides)."

5) SURFACE CONDITION

5.1. Weld Surface

The weld surface shall be prepared as needed to present a smooth contour, avoiding sharp changes in section. Where such changes in section occur, it is possible that some difficulty in the ultrasonic interpretation may occur. Such difficulties must be recorded on the report.

5.2. Parent Material

The parent material shall be free from weld spatter, surface irregularities or foreign matter that might interfere with the examination, giving a smooth contour for a distance of at least 2 ½ t on each side of the weld on each of the testing surfaces (where t is the thickness of the material under test). Where 70˚ angle probes are employed, the distance shall be increased to 3 ½ t.

6 .EXAMINATION

6.1.1 The scanning requirements of this procedure are based on the use of at least two probes of differing angles from each side of the weld.

SENSITIVITY

The scanning sensitivity should be set to twice the primary reference level(+6dB). All indications in excess of 20% of the DAC should be evaluated when assessed at the primary reference level. A DAC curve is required for all welds. For examination of a full wall thickness, the notches shall be used as calibration reflectors. A side-drilled hole may be used for initial acceptance of a weld, provided that it can be demonstrated that the hole calibration produces a sensitivity equal to or greater than the notch calibration.

Distance amplitude correction:

a) DAC curves will be constructed for every search unit to be utilized at each particular range used, for reference during all weldments examination. Block used for DAC construction will be selected as appropriate from those as specified in ASME Section, Article4, figure T-434.2.1, T-434.3 DAC curves will be constructed as follow:

b) Place the probe on the calibration block to obtain a reflection from the hole, which produces the greatest response.

c) Maximize the indication by manipulation and adjusted to approx.75% screen height using the calibration gain control. Make a mark on the CRT at the peak of the indication using an indelible fine tipped felt maker.

d) Points representing 20% and 50% of the primary gain are also to be constructed. Repeat b) and c) using reflections from every reflect or than can be obtained within the beam length of the test range to be used, including those reflections obtained from skip.

Connect all points marked with a smooth curving line, this line will be referenced to as the DAC curve the respective probe used and will apply for that particular search unit.

Note: DAC curves will be directly marked as the CRT time base screen cover with an indelible ink marker or superimposed using clear plastic, Polyester or Perspex overlap.

Should the DAC curve fail to search a level of at least 20% of full screen height at the limit of its range, as represented on the time base, sufficient supplementary gain will be added to attain this level and the DAC adjusted accordingly.

6.2 Calibration

6.2.1 Straight Beam Examination (0° Probe)

a) The equipment is calibrated using a straight beam probe for a suitable range for the thickness of material being examined. A minimum of two back wall echoes from the material under test shall be noted during the examination.

b) A Distance Amplitude Correction curve (DAC curve) shall be produced using the appropriate calibration block selected in accordance with paragraph 4.3

The attenuator control is adjusted to produce a response of 80% full screen height and the screen is marked. The probe is then re-positioned to give the maximized response for each of the remaining holes on ASMW block (basic calibration block) without changing the attenuator settings. At each maximized position, mark the position of maximum response on the screen. Connect the screen marks to produce the DAC curve. This gain setting is the primary reference level.

6.2.2 Angle Beam Calibration

(a) The equipment is calibrated for a suitable range for the beam path length required to satisfactorily complete the examination, i.e. Full Skip Distance by calibration ASME block (basic calibration block)

(b) Produce a DAC curve in accordance with paragraph 6.1.3.

System calibration confirmation shall be carried out at the commencement of, and at 4 hourly intervals during the examination after any break where the equipment has been switched off, and on completion of an examination.

If during the calibration confirmation the sweep range of the DAC curve has changed by the following tolerances: (i) Sweep Range - if a point of the DAC curve has moved on the time base by more than 10% of its original time base position, or (ii) DAC Curve - if a point on the DAC curve has changed by ± 20% or 2 dB from its original amplitude; then the following action shall be taken:

6.3.1 Sweep Range

The calibration shall be corrected with a note of the correction being made on the report. If any signals have been recorded, all recorded indications shall be re-examined with the corrected calibration and their values corrected accordingly on the report.

6.3.2 DAC Curve

If any point on the DAC curve has decreased by 20% or 2dB all recorded data since the last valid calibration shall be marked void. A new DAC curve shall be produced with a note to this effect on the report and the voided areas shall be re-examined. If any point on the DAC Curve has increased

by 20% or 2dB all recorded data since the last valid calibration shall be reassessed following the production of the new DAC curve. A note - of this shall be made on the report.

7) CALIBRATION

7. 1 General Calibration Requirements

7.1.1. Ultrasonic System. Calibrations shall include the complete ultrasonic system and shall be performed prior to use of the system in the thickness range under examination.

7.1.2. Calibration Surface. Calibrations shall be performed from the surface (clad or unclad; convex or concave) corresponding to the surface of the component from which the examination will be performed.

7.1.3. Couplant. The same couplant to be used during the examination shall be used for calibration.

7.1.4. Contact Wedges. The same contact wedges to be used during the examination shall be used for calibration.

7.1.5. Instrument Controls. Any control which affects instrument linearity (e.g., filters, reject, or clipping) shall be in the same position for calibration, calibration checks, instrument linearity checks, and examination.

7.1.6. Temperature. For contact examination, the temperature differential between the calibration block and examination surfaces shall be within 14°C. For immersion examination, the couplant temperature for calibration shall be within 14°C of the couplant temperature for examination.

8) EXAMINATION TECHNIQUE

All scans shall be carried out with a minimum overlap of 10% of the transducer diameter.

8.8.1. Parent Metal Examination

Prior to any examination of the weldment, the parent material shall be examined. A compression waves 0˚ examination will be carried out for a minimum of 75mm either side of the weld to locate any flaws in the parent material and to determine its thickness. For thicknesses up to 30mm, a twin crystal probe shall be used. For thicknesses over 30 mm, a single crystal probe shall be used.

8.8.2. Weld Material - “Pipe & Welds”

8.8.2.1 If the weld cap has been removed the center line of the weld shall be determined by locating the position of maximum response from the weld root. Weld Material T, K, Y, Nozzle or Node Configurations.

Where the back of a weld is accessible, a normal probe should be used to outline projected weld limits on to the testing surface.

The probe should be placed on the parent material and the first return echo from the remote surface should be set to 80% full screen height. The probe should then be scanned across the weld zone until the echo amplitude is reduced by 6 dB as it crosses the projected weld edge and its position should be marked on the surface. This scan is to be repeated behind each weld edge until a series of marks are produced which when joined represent the projected weld profile.

8.8.3 Weld Examination. Plate & Pipe Welds

8.8.3.1 A critical root scan shall be carried out from both sides of the weld, with at least one angle probe directed essentially perpendicular to the weld axis so as to distinguish between root variations and the existence of root cracks or crack-like defects. This shall be done where practicable with the aid of a magnetic strip placed so that the distance from the probe index to the root will be constant. The body and fusion faces of the weld shall then be examined using a continuous scanning raster from both sides of the weld between the weld center line or the cap edge whichever is appropriate and full skip plus the cap width using at least two probes of differing angles.

8.8.3.2 T, K & Y Configurations

(a) Scanning from the 'flange'

Using 45° and 60° probes, the weld zone should be examined in two directions with the probe directed essentially perpendicular to the weld edge, examining the flange and weld material between the two weld toes.

(b) Scanning of Perpendicular 'T' butt welds

Using any two angle probes, where angles differ by at least 10° the weld area should be searched from the 'web'. Where full coverage of the complete weld zone is not possible when scanning from one side of the 'web' then scanning from two sides of the web must be carried out whenever possible.

The selected probe angle should be selected to be as nearly perpendicular to the fusion face as possible whilst maintaining the search distance to the most practicable minimum.

(c) Scanning of inclined or circular cross section 'T' butt-welds

The examination of inclined and circular 'T' butt configurations may introduce geometric difficulties. In such cases then a series of cross-sectional drawings must be prepared for each significant change in the geometry. Selection of the appropriate probe angle will depend upon the specific geometric configurations at particular locations.

8.8.3.3 Set on Branch Welds

A characteristic of these welds is the severe change in weld cross-section around the circumference, which makes coverage of the 'B' side wall particularly difficult and calls for a combination of scans. For this reason, unless there is adequate access for examination from the bores of both welded components, the weld cap/fillet surface shall be dressed if required to allow probes to be scanned on this surface.

The following scans are required (See figure 1 for Scan Position).

Root		Scan Q1
'A' Fusion Face	(i)	When bore access allows: scan P1 and Q2.
	(ii)	In other cases: Scan Q2.
'B' Fusion Face	(i)	When bore access allows: scans P3 and S2.
	(ii)	In other cases: select from scans Q1, Q2, Fl and R1 as applicable.
Weld Body	(i)	When bore access allows: scan P2.

8.8.3.4 Set on Nozzle Welds

The following scans are required (See figure 1 for scan position).

Root		Scan Q1
'A' Fusion Face	(i)	When bore access allows: scan P1 and Q2.
	(ii)	In other cases: scan Q2.
'B' Fusion Face	(i)	When bore access allows: scan S2, supplemented by scan P3, particularly for sizing defects.
	(ii)	In other cases: scans Q1 and Q2 supplemented if required by scan Fl to give full coverage.
Weld Body	(i)	When bore access allows: scan P2.
	(ii)	In other cases no further scans are practicable.

Transverse Defects not normally a requirement on this type of weld, and of limited effectiveness due to unfavorable joint geometry.

8.8.3.5 Set on Stub Welds

The following scans are required: (See figure 1 for scan positions).

Root	Scan Q1
'A' Fusion Face	Scan Q2

'B' Fusion Face Scan Q2

Weld Body No additional scans are practicable. Transverse

Defects Scanning for transverse defects is not applicable.

8.8.3.6 Set through Connections and T Butt Welds

The following scans are required: (See figure 1 for scan position).

Root (i) When bore 'A' access allows: scan P2 or P1 in both directions.

(ii) In other cases: scans R1 and either R2 or S1. 'A'

Fusion Face (i) When bore 'A' access allows: scan P2.

(ii) In other cases: Scans Fl, R1 and either R2 or S1.

'B' Fusion Face (i) When bore 'A' access allows: scans R1 and S1, or P1 in both directions.

(ii) In other cases: scans R1 and either R2 or S1.

Weld Body No specific extra scans required.

Transverse Defects Scans for transverse defects are not normally a requirement on this type of weld; a limited standard of examination only may be achieved by scanning from the weld cap or from the bore of component 'A'.

8.9 Defect Evaluation and Sizing

8.9.1. Any signals having amplitude in excess of 20% DAC, observed during the examination shall be further investigated to:

i. Confirm its existence

ii. Determine its location with reference to the established datum points.

iii. Determine its size.

iv. Determine its nature.

8.9.2. This investigation may require scanning from other positions and with different probe angles and is highly subjective in its nature and should be carried out with extreme care.

The recommended sizing techniques are as follows:

8.9.3. Defect Length

Use the -6dB drop technique - marking the probe center at the defect end points. Subsidiary maximum at the ends of the defect should be treated independently of the major defect for overall assessment of length.

8.9.4. Through Thickness Dimension

Use the maximum amplitude technique or -20dB drop technique in conjunction with adjustable flaw

location aids.

8.9.5. Recording Indications

The recording levels and rejection levels shall be in accordance with the referencing code (T-591.1, T-591.2 of ASME sec V article5) & project specification.

9) ACCEPTANCE CRITERIA

The levels of acceptance shall be accordance to ASME Sec. VIII Appendix 12 (Edition 2019) as below:

Imperfections which produce a response greater than 20% of the reference level shall be investigated to the extent that the operator can determine the shape, identity, and location of all such imperfections and evaluate them in terms of the acceptance standards given in (a) and (b) below.

(a) Indications characterized as cracks, lack of fusion, or incomplete penetrations are unacceptable regardless of length.

(b) Other imperfections are unacceptable if the indications exceed the reference level amplitude and have lengths which exceed:

1. 1/4 in.(6mm) for *t* up to 19 mm;
2. 1/3 *t* for *t* from 19 mm to 57 mm;
3. 3/4 in. (19mm) for *t* over 57 mm.

Where *t* is the thickness of the weld excluding any allowable reinforcement.

For a butt weld joining two members having different thicknesses at the weld, *t* is the thinner of these two thicknesses. If a full penetration weld includes a fillet weld, the thicknesses of the throat of the fillet shall be included in *t*.

10) EXAMINATION & RECORDS REPORTING

The reports of each weld examined must include all the relevant calibration data, to permit a duplicate examination at a later date. The reports may omit certain criteria providing the information is readily available by cross reference to a Contract specific Technique / Procedure sheet.

The report must also include all the data relevant to the work-piece together with a sketch, where appropriate, of the work piece or the defects detected.

The method of completion of the report should ensure all boxes are completed; where not applicable, the abbreviation ‘N/A’ inserted, or where not known the abbreviation ‘N/K’ inserted.

The examination standard, acceptance standard and referenced NDT

Inspection/Technique/Procedure sheet must be clearly stated on the report.

Where necessary these shall be accompanied by a sketch or drawing.

All test restrictions and or deviations from the specific Technique sheet must be entered on the report and the client informed if the test result may be affected.

The report should include, factually or by cross referral, the following as a minimum: -

(a) Manufacture name
(b) Project name
(c) Item no
(d) Weld no
(e) Acceptance standards
(f) Material type & thickness
(g) Specific Technique reference
(h) Equipment Used
(i) Operator's name & Qualifications
(j) Calibration details
(k) I.D & location of weld and area tested
(l) Surface(s) from which test is conducted
(m) Map or sketch of location of defects found
(n) Date of test
(o) Couplant used
(p) Basic calibration block identification
(q) Surface condition
(r) Probes & Frequency
(s) Special Equipment
(t) Client details and location and/or clear areas
(u) "All related document/ instruments shall be available to inspectors to be peer reviewed as their request. Also, they are allowed to challenge the interpretation and request additional/repeat NDE at their discretion."

11) PROCEDURE QUALIFICATION

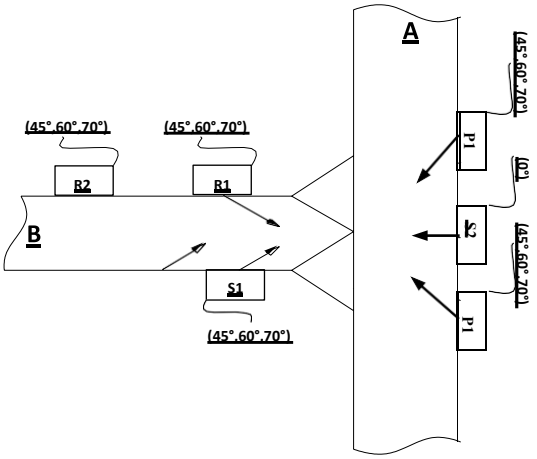
When procedure qualification is specified, a change of a requirement identified as an essential variable shall require requalification of the written procedure by demonstration. A change of a requirement identified as a nonessential variable does not require requalification of the written procedure. All changes of essential or

nonessential variables from those specified within the written procedure shall require revision of, or an addendum to, the written procedure.

FIGURE 1 (Typical)

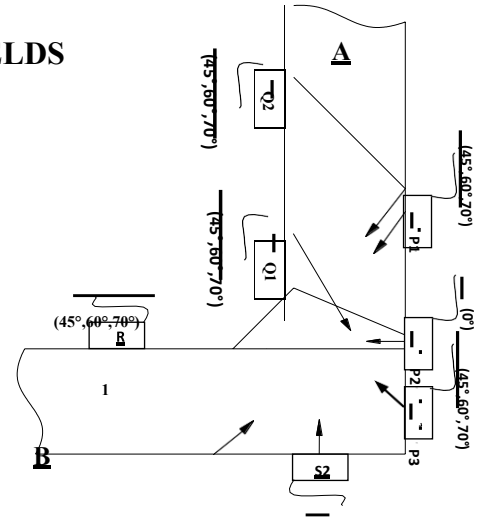
(a) SET - ON CONNECTIONS

1) BRANCH WELDS: - BORE A > 0.5 BORE B
2) NOZZLE WELDS: - BORE A < 0.5 BORE B
3) STUB WELDS: THICKNESS A < 12.5mm



(b) SET THROUGH CONNECTIONS AND T' BUTT WELDS

1) SET THRO. CONNECTION. FULL PENETRATION
2) SET THRO. CONNECTION. PARTIAL PENETRATION
3) 'T' BUTT WELD. FULL PENETRATION
4) 'T' BUTT WELD. PARTIAL PENETRATION



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12- POST EXAMINATION CLEANING

Post cleaning shall be performed immediately after examination and evaluation by proper process that does not adversely effect on related part.

MAGNETIC PARTICLE EXAMINATION

PROCEDURE

Contents

1)Scope

This article contains methods and requirements for Magnetic Particle Examination of Heat Exchanger.

2)Reference

- ASME Sec. V, Article 7, (Edition 2019)
- ASME Sec. VIII, Div. 1, (Edition 2019)
- ASNT-TC-1A (Latest Edition)

3)Surface Preparation

3.1. Satisfactory results are usually obtained when the surfaces are as welded conditions. however, surface preparation by grinding or machining may be necessary where surface irregularities could make indication due to discontinuities.

3.2. Prior to magnetic particle examination, the surface to be examined and all adjacent area within at least 25.4 mm shall be dry and free of all dirt, grease, welding flux and spatter, oil or other extraneous matter that could interfere with the examination.

3.3. Cleaning may be accomplished using detergents, organic solvents, paint remover, vapor degreasing, grit blasting, or ultrasonic cleaning methods.

3.4. If coatings are left on the part in the area being examined, it must be demonstrated that indication can be detected through the existing maximum coating thickness applied.

4)Magnetic Particles

4.1. The magnetic particles used for finding discontinuities will be wet method. Powders for wet test are non- fluorescent. The powders used will be as liquid suspension, they shall have a high permeability and a low capacity of keeping magnetization. Particles shall be visible under normal light. The following powders and / or similar will be used:

- Natural light black (magnaflux or equivalent)
- Red (magnaflux or equivalent)

4.2. Two types of Liquid Carriers may be used:

4.2.1. Oil - bath

The oil used in preparing the bath shall be light oil or refined oil having a low Sulphur and chloride limits content: Further it shall completely with the requirement of the ASME regulations.

When using oil as carrier of fluorescent particles, it shall be controlled by black light so that is gets only minimum quantity of natural fluorescence.

4.2.2. Water - bath

The water shall contain wetting substances and corrosion inhibitors. Bath concentration shall be in compliance with the applicable standard.

4.3. The temperature of the wet particle suspension and the surfaces of the part shall not exceed 52

°C.

- The following powders and / or similar

will be used: Natural light black

(magnaflux or equivalent) Red

(magnaflux or equivalent)

5)Magnetization Method

5.1. The Electromagnetic Yoke Technique shall be used. This method shall be performed only to surface and sub-surface discontinuities.

5.2. The AC magnetizing technique will be used provided that it has a 4.5 kg lifting that weighed with a scale from a reputable manufacturer. This test shall be performed before use; recording of this test is not required.

5.3. The DC technique will be used provided that it has 18 kg lifting capacity at the maximum Pole spacing. This test shall be performed before use; recording of this test is not required.

5.4. Two examinations at least shall be carried out in every area where the prods are placed so that the flux lines result approximately perpendicular.

5.5. Two examination at least shall be carried out with a sufficient overlapping (MIN. 15% overlapped) so as to ensure the 100% covering of the surface to be tested.

5.6. The following equipment and /or similar can

be used: MAGNAFLUX – Y6

TIDE – GWM 220

6)Demagnetization

When residual magnetism in the part could interfere with subsequent or usage, the part shall be demagnetized any time after completion of the examination.

7)Magnetic Field Checking

Whenever starting or completing an MT examination, direction and suitability of the magnetic field shall be checked by using the field indicator.

8) Method of Examination

Examination shall be done by continuous method: that is the magnetizing current remains on while the examination medium in being applied and while excess of the examination medium is being removed.

9) Interpretation

9.1 Non – fluorescent particles:

For Non–fluorescent particles examination is performed using visible light. A minimum light intensity of 50 FC (500 Lx) is required to ensure adequate sensitivity during the examination and evaluation of indication.

9.2 Fluorescent particles:

For this method the examination is performed using an ultraviolet lamp.

a) The examination shall be performed in a darkened area.

b) The examiner shall be in the darkened area at 5 min prior to performing the examination to enable his eyes to adapt to dark viewing. If the examiner wears glasses or lenses, they shall not to be photosensitive.

c) The ultraviolet light shall be allowed to warm up for a minimum of 5 minute prior to use or measurement of the intensity of the ultraviolet light emitted.

d) The ultraviolet light intensity shall be measured with an ultraviolet light meter. A minimum of 1000 uw/cm 2 the surface of the part to be examined shall be required. The black light intensity shall be measured at least once

10) Procedure Qualification

10.1. Procedure Requirements: Magnetic particle examination shall be performed in accordance with a written procedure which shall as a minimum, contain the requirements listed in Table T-721, ASME Sec. VIII, Div.1. The written procedure shall establish a single value, or range of values, for

each requirement.

10.2. Procedure Qualification: When procedure qualification is specified, a change of requirement identified as an essential variable from the specified value, or range of values, shall require requalification of the written procedure. A change of a requirement identified as a nonessential variable from the specified value, or range of values, does not require re qualification of the written procedure. All changes of essential or nonessential variables from the value, or range of values, specified by the written procedure shall require revision of, or an addendum to, the written procedure.

11) Indications Evaluation

11.1. All indication shall be evaluated in terms of the acceptance of the referencing code section.

11.2. Discontinuities on or near the surface indicated by retention of the examination medium.

11.3. Broad areas of particle accumulation, which might mask indication from discontinuities, are prohibited, and such areas shall be cleaned and re-examined.

11.4. Only indications, which have any dimensions greater than 1/16in, shall be considered relevant. A linear indication is one having a length greater than three times the width. A rounded indication is one of circular or elliptical shape with a length equal to or less than three times the width. Any questionable or doubtful indication shall be re-examined to determine whether or not they are relevant.

11.5. "All related document/ instruments shall be available to inspectors to be peer reviewed as their request. Also, they are allowed to challenge the interpretation and request additional/repeat NDE at their discretion."

12) Acceptance Criteria

e) In any case all surfaces to be examined shall be free of:

f) Relevant linear indications.

g) Relevant rounded indication greater than 5 mm.

h) Four or more relevant rounded indication in a line separated by 1.5 mm or less, edge to edge.

i) Under cut of welds shall not exceed 0.3 mm

13) Post Cleaning

When Post-examination cleaning is required; it should be conducted as soon as practical using a process that does not adversely affect the part. The techniques employed are:

- Drying of wet particles and subsequent removal by brushing or compressed air.
- Removal of wet particles by flushing with proper solvent.

Other suitable techniques may be used if they will not interfere with subsequent requirements.

14) Personnel Qualification

Personnel involving in this examination in compliance with this procedure shall be qualified according to SNT-TC-1A, Level I as operator and Level II as examiner.

15) Calibration of Equipment

15.1. Frequency:

Magnetizing equipment with an ammeter shall be calibrated at least once a year, or whenever the equipment has been subjected to major electric repair, periodic overhaul, or damage. If equipment has not been in use for a year or more, calibration shall be done prior to first use.

15.2. Procedure:

The accuracy of the unit's meter shall be verified annually by equipment traceable to a national standard. Comparative readings shall be taken for at least three different current output levels encompassing the usable range.

15.3. Tolerance:

The unit’s meter reading shall not deviate by more than ±10% of full scale, relative to the actual current value as shown by the test meter.

15.4. Light Meters:

Light meters shall be calibrated at least once a year or whenever the meter has been repaired. If meters have not been in use for one year or more, calibration shall be done before being used.

VISUAL INSPECTION PROCEDURE

Contents:

1) Scope

This Article contains methods and requirements for visual examination applicable when specified by a referencing Code Section. Specific visual examination procedures required for every type of examination are not included in this Article, because there are many applications where visual examinations are required.

2) Reference

- ASME Sec. V, Article 9 (2019 edition)
- ASME Sec. VIII (2019 edition)
- ASME Sec. IX (2019 edition)
- ASTM-E94- Nondestructive testing
- ASTM -E149- Control quality of radiography testing
- ASNT-TC-1A (Latest Edition)
- NIOEC-SP-41-03, NIOEC-SP-44-03
- 3034-00-ED-SE-JSP-44003-A2
- 3034-00-ED-SE-JSP-42001-A3.
- TEMA –Standard Class “R” - 8th edition
- 3034-MT-JSP-AA350

-04/EB-ME/OTH-R-0005 Rev. A Unfired pressure vessels (Based on HTAS Standard No. 4-1361/E).

3) Procedure Qualification

When procedure qualification is specified by the referencing Code Section, a change of a requirement listed in Table T-921 ASME Sec.V identified as an essential variable shall require requalification of the written procedure by demonstration. A change of a requirement identified as a nonessential variable does not require requalification of the written procedure. All changes of essential variables from those specified within the written procedure shall require revision of, or an addendum to, the written procedure.

4) Personnel Requirement

The user of this Article shall be responsible for assigning qualified personnel to perform visual

examinations to the requirements of this Article. As a minimum, interpretation must be carried-out by inspectors holding at least valid certificate to ASNT-TC-1A level II.

5) Physical Requirements

Personnel shall have an annual vision test to assure natural or corrected near distance acuity such that they capable of reading standard J-1 letters on standard Jaeger test type charts for near vision.

6) Equipment

Equipment used for visual examination techniques, for example, direct visual examination, shall have the proper capabilities. Capabilities include, but are not limited to viewing, magnifying, identifying, measuring, and/or recording observations in accordance with requirements of the referencing Code Section.

7) Technique

7.1) Applications

Visual examination is generally used to determine such things as the surface condition of the part, alignment of mating surfaces, shape, or evidence of leaking. In addition, visual examination is used to determine a composite material's (translucent laminate) subsurface conditions.

7.2) Direct Visual Examination

Direct visual examination may usually be made when access is sufficient to place the eye within 24 in. (600 mm) of the surface to be examined and at an angle not less than 30 deg to the surface to be examined. Mirrors may be used to improve the angle of vision, and aids such as a magnifying lens may be used to assist examinations. Illumination (natural or supplemental white light) for the specific part, component, vessel, or section thereof being examined is required. The minimum light intensity at the examination surface/site shall be 100 foot candles (1000 lux).

8) Evaluation

All examinations shall be evaluated in terms of the acceptance standards of the referencing Code Section.

9) Documentation

9.1) A written report of the examination shall contain the following information:

(a) the date of the examination

(b) procedure identification and revision used

(c) technique used

(d) results of the examination

(e) examination personnel identity, and, when required

by the referencing Code Section, qualification level

(f) identification of the part or component examined

9.2) Even though dimensions, etc., were recorded in the process of visual examination to aid in the evaluation, there need not be documentation of each viewing or each dimensional check.

10) Acceptance Criteria

10.1) Relevant Defects

The accessible surfaces of the welds shall be examined visually with no magnification required. The welds shall show complete fusion and no evidence of burning through the weld, and shall be free from cracking or porosity.

In addition, all surfaces to be examined shall be free of:

(a) relevant linear indications

(b) relevant rounded indications greater than 5 mm

(c) four or more relevant rounded indications in a line separated by 1.5 mm or less (edge to edge)

10.2) Alignment Tolerances

(a) Alignment of sections at edges to be butt welded shall be such that the maximum offset is not greater than the applicable amount for the welded joint category under consideration, as listed in Table 1. The section thickness t is the nominal thickness of the thinner section at the joint.

(b) Any offset within the allowable tolerance provided above shall be faired at a three to one taper over the width of the finished weld, or if necessary, by adding additional weld metal beyond what would otherwise be the edge of the weld. Such additional weld metal buildup shall be subject to the

requirements of UW-42.

Table 1 (UW-33)

Section thickness (mm)	Joint Categories	
	A	B, C & D
Up to 13, incl.	1/4 t	1/4 t
Over 13 to 19, incl.	3 mm	1/4 t
Over 19 to 38, incl.	3 mm	5 mm
Over 38 to 51, incl.	3 mm	1/8 t
Over 51	Lesser of 1/16 t or 10mm	Lesser of 1/8 t or 19 mm

10.3) Finished Longitudinal & Circumferential Joints

(a) Butt welded joints shall have complete penetration and full fusion. As welded surfaces are permitted, However the surface of welds shall be sufficiently free from coarse ripples, grooves, Overlaps, and abrupt ridges and valleys to permit proper interpretation of radiographic and other required NDT.

(b) A reduction in thickness (under cut) due to the welding process is acceptable provided all of the following conditions are met.

(c) The reduction in thickness shall not reduce the material of the adjoining surfaces below the minimum required thickness at any point.

(d) The reduction in thickness shall not exceeded 1/32 in (0.8 mm) or 10% of nominal thickness of the adjoining surface whichever in less.

(e) To assure that the weld grooves are completely filled. So that the surface of the weld metal at any point does not fall below the surface of the adjoining base materials weld metal may be added as reinforcement on each face of the weld. The thickness of the weld reinforcement on each face shall not exceed in table (2).

(e) Concavity due to the welding process on the root side of a single welded circumferential Butt weld is permitted when the resulting thickness of the weld is at least equal to the thickness of the thinner member of the two sections being joined and the contour of the concavity is smooth.

Table 2 (UW-35)

Material nominal thickness (mm)	Maximum reinforcement(mm)	
	Category B & C Butt welds	Other welds
Less than 2.4	2.4	0.8
2.4 to 4.8 incl.	3.2	1.6
Over 4.8 to 13 incl.	4.0	2.4
Over 13 to 25 incl.	4.8	2.4
Over 25 to 51 incl.	5	3.2
Over 51 to 76 incl.	6	4
Over 76 to 102 incl.	6	6
Over 102 to 127 incl.	6	6
Over 127	8	8

MAGNATIC PARTICLE TESTING REPORT

EQUIPMENT NO.:	
DATE:	
REPORT NO.:	

Equipment Name:	REPORT NO.:	SHEET : OF	DATE:
DRAWING NO.:		STANDARD:	
TESTING SUBJECT:	BASE METAL:		

MAGNETIZING FORCE:

CURRENT TYPE AC ☐ DC HWR ☐ FWR ☐

TYPE OF MAGNETIC FIELD LONGITUDINA CIRCULAR ☐

MAGNETIZING METHOD:

COIL ☐ PROD ☐ HEAD SHOT ☐ FLEXIBLE CABLE ☐ CENTERAL CONDUCTOR ☐ YOKE

MEDIUMS: WET DRY ☐ FLUORESCENT ☐ VISIBLE ☐

MAGNETIC PARIIED: COLOR ☐ DRY ☐ WET ☐ HUORESCENT ☐ OTHER ☐

SURFACE CONDITION: AS WELD AS FORGED ☐ BRUSH ☐ AS MACHINED ☐ OTHER ☐

ROW	WELD NO.	MT NO.	MATERIAL	RESULT 1		RESULT 2		REMARK
				ACC.	REJ	ACC.	REJ	

INTERPRETER	VENDOR	OWNER/TPI
NAME:	NAME:	NAME:
SIGN:	SIGN:	SIGN:
DATE:	DATE:	DATE:

Vendor:	**LIQUID PENETRANT TEST REPORT**		EQUIPMENT NO.:
			Date:
			REPORT NO.:
			Page: **OF**

Applicable code :	**Stage of Examination**
Procedure ID:	
Material:	**Prepared Edge:** **After P.W.H.T** ☐ **As welded** ☐ **After Hydro .test** ☐ **Others** ☐

Surface preparation : **Grinding** ☐ **Machining** ☐ **Power Brush** ☐ **Others** ☐

Penetrant	**Type**	☐ Color Contrast	☐ Fluorescent
	Application	☐ Brushing	☐ Spraying
	Temperature : Ambient temp.	**Penetrate time:** 10 Minutes	**Penetrant Designation:**
Removal	☐ Water Washable Penetrant		**Removal Designation:**
	☐ Post Emulsifying Penetrant		
	☐ Solvent Removable Penetrant		
Developing	☐ Dry developer		**Developing Designation:**
	☐ Wet developer		

Row	**Item**	**Joint NO.**	**THK (mm)**	**Defect Type**	**Location**	**Dimension (mm)**	**Result**		**Remark**
							Repair	**Accept**	
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

NOTE :

Judgment : Satisfactory ☐ unsatisfactory ☐

Interpretar	**VENDOR**	**OWNER/TPA**
NAME:	NAME:	NAME:
DATE:	DATE:	DATE:
SIGNATURE:	SIGNATURE:	SIGNATURE:

RADIOGRAPHY EXAMINATION REPORT

Project: **Item No.:** **Procedure:** **Code/Standard: ASME Sec VIII**	**Technique :** ☑ SWSI ☐ DWSI ☐ DWDI ☐ Pano **Film Type :** ☑ AA400 ☐ AGFA D4 ☑ MX125 ☑ R 4 **IQI:** ☐ 13~19 ☑ 10~16 ☐ 6~12 ☐ 1~7 **Density:** ☑ 2~2.5 ☑ 2.5~3 ☑ 3~3.5 ☐ 3.5~4	**Source Type:** γ ☑ x ☐ **Source Size :2X3mm** **Source Strength:56**	**Report No:** **Sensitivity:2% Max**	**Date:** **UG:0.5 Max**	**Page: 1 of 1**

Row	RT No :	JOINT.NO	SFD	THK(mm)	Welder Stamp	Req No	Weld Length (mm)	Film Length (cm)	Result 1				Result 2				Result 3				Defects Type & Location(cm)
									Acc	Rep	RS	RT	Acc	Rep	RS	RT	Acc	Rep	RS	RT	

Legend							
LC: Longitudinal Crack	**LOF**: Lack of Fusion	**CP**: Cluster Porosity	**PP**: Pipe Porosity	**SI**: Slag Inclusion	**RC**: Root Concavity	**Acc:**Accept
TC: Transverse Crack	**LOP**: Lack of Penetration	**PO**: Spherical Porosity	**CV:**Cavities	**TI**: Tungsten Inclusion	**EP**: Excess Penetration	**RS:**Reshoot
SC: Star Crack	**RU**: Root Undercut	**RPO**: Random Porosity	**WH**: Worm Hole	**OI:** Oxid Inclusion	**UF**: Under Fill	**Rep:**Repair
CC: Crater Crack	**CU**: Cap Undercut	**LP:** Linear Porosity	**PH**: Pin Hole	**BT**: Burn Through	**HB**: Hollow Bead	**RT:**Retake

INTERPRETER	VENDOR	OWNER/TPI
DATE:	**DATE:**	**DATE:**
NAME:	**NAME:**	**NAME:**
SIGN:	**SIGN:**	**SIGN:**

ULTRASONIC EXAMINATION REPORT

EQUIPMENT NO.:	
Date:	
REPORT NO.:	
PAGE NO.:	

PROCEDURE ID:	**THICKNESS:**	**SEARCH UNIT:**	**COUPLANT:**
ACCEPTANCE CRITERIA:	mm	MAKER: FREQUENCY:	OIL ☐ GREASE ☐ GLYCERIN ☐
GROOVE TYPE:	Inch	TYPE & SIZE:	SCA ☐ WATER ☐ CELLULOSE PASTE ☐
V ☐ U ☐ X ☐	**WELDING PROCESS:**	**SEARCH UNIT CABLE(S):**	**EQUIPMENT FUNCTION:**
K ☐ Y ☐ OTHER ☐	SMAW ☐ GMAW ☐ GTAW ☐	TYPE: Lenght:	TOLERANCE OF SCREEN HIGH LINEARITY:
SURFACE CONDITION:	FCAW ☐ SAW ☐ OTHER ☐	**TEST BLOCKS:**	TOLERANCE OF AMPLITUDE CONTROL LINEARITY:
AS WELD ☐ AS FORGED ☐	**EQUIPMENT**	CALIBRATION :	**EXAMINATION METHOD**
AS MACHINED ☐ AS CAST ☐	MAKER:	BASIC MATERIAL:	PULSE-ECHO ☐ STRAIGHT BEAM ☐ ANGLE BEAM ☐
AS GRINDED ☐ OTHER ☐	MODEL:	CALIBRATION dB: SCANNING dB:	IMMERSION ☐ CONTACT ☐ ROUGH TRANSMISSION ☐

NO.	ITEM	JOINT	Weld Length (mm)	SCAN AREA (mm)	DEFECT LOCATION			INTERPRETATION	RESULT		REMARKS
					X	L	D		ACCEPT	REJECT	

Judgment : Satisfactory ☐ Unsatisfactory ☐

INTERPRETER	**VENDOR**	**OWNER/TPI**
NAME	**NAME**	**NAME**
SIGN	**SIGN**	**SIGN**
DATE	**DATE**	**DATE**

WELDING VISUAL INSPECTION REPORT

OWNER REQ. NO.:	PROJECT NO.:	ITEM NO.:	REPORT NO.:	PAGE:	DATE:
KAS-0206-07	HX126	ALL ITEM	FPA-HX126-VT-001	1 of 1	

Row No.	Weld Identification	WPS NO.	MATERIAL (TYPE 1/ TYPE 2)	WELDER STAMP			RESULT
				ROOT	FILLING	CAP	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

INTERPRETAR	VENDOR	OWNER/TPI
NAME:	NAME:	NAME:
DATE:	DATE:	DATE:
SIGN.:	SIGN.:	SIGN.: